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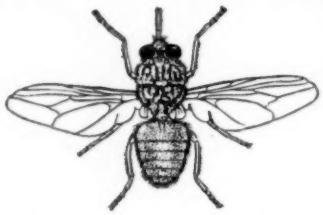

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Immunisation of Lambs against *Clostridium welchii* type D Enterotoxaemia (Pulpy Kidney Disease) with a Purified Toxoid Aluminium Treated

BY

J. R. HEPPLE and K. S. CHODNIK

Glaxo Laboratories Ltd., Greenford, Middlesex

AND

E. K. PRICE

Royal Veterinary College, London

SUMMARY.—The preparation of a Cl. welchii *type D purified toxoid, aluminium treated, is described, and an account is given of the examination of this material for its efficiency and safety in immunising 8,410 sheep and lambs against enterotoxaemia due to* Cl. welchii *type D (pulpy kidney disease).*

The material has been shown to be safe, as no untoward reaction occurred in any of the sheep injected. The material was also shown to be efficient, since 147 animals selected at random and examined by blood sampling were immune after 2 injections of 2 ml.

During the 4 months after the injections 15 deaths were reported in lambs in the various flocks but no cases of pulpy kidney disease were diagnosed.

A large proportion of lambs born to ewes immunised during pregnancy, and then themselves injected for the first time with the material at about 4 weeks of age, remained continuously immune throughout the period of examination.

Further investigation into the last mentioned method of immunisation is described.

Of 58 lambs born to ewes injected during pregnancy with 2 ml. of the material, all were immune at birth and at 5 weeks of age. Of these lambs 19 received no further treatment and 10 per cent. were not immune at 9 weeks of age, 31 per cent. were not immune at 11 and 13 weeks and 73 per cent. were not immune at 15 weeks. The remaining 39 lambs received an injection of 2 ml. of the material at 5 weeks of age and were still all immune at 9 weeks of age. Of these 39 lambs 19 were given a second injection of 2 ml. of the material 4 weeks after their first injection and were still well immunised at 15 weeks of age, whereas the remaining 20 lambs, which had not received the second injection, were all immune at 13 weeks, though 20 per cent. were no longer immune at 15 weeks of age.

A programme that should establish and maintain an adequate level of flock immunity against the disease is suggested.

Introduction

ENTEROTOXAEMIA of sheep and lambs caused by *Clostridium welchii* type D (pulpy kidney disease) is now generally recognised to occur in sheep of all ages and at all times of the year, though there are peaks of incidence—in the spring among young suckling lambs and in the early autumn among store and fattening sheep. Death from this disease is due to absorption into the circulation of ϵ-toxin produced by proliferation of the causative organism in the intestine.

Bullen (1952) has shown that many normal sheep carry the organisms in their intestines and that substantial numbers of such sheep evidently experience subclinical infection, judged by the appearance of measurable levels of *Cl. welchii* ϵ-antitoxin in their sera. It has also been shown (Bullen & Batty, 1957) that the disease may occur spontaneously in sheep harbouring the organism if the amount of starch in their diets is suddenly increased.

Control of the disease by active immunisation is thus of considerable importance, and Thomson & Batty (1953) calculated the minimum level of circulating ϵ-antitoxin required at any time to prevent death due to pulpy kidney disease as being of the order of 0·1 units of antitoxin per ml. of serum. They demonstrated that alum-precipitated trypsin-treated toxoid was an efficient immunising agent, and it was later shown that such a preparation could be used safely and effectively on both pregnant ewes and new-born lambs (Batty, Thomson & Hepple, 1954).

Since local reactions are occasionally caused by injection of such preparations, particular attention has been directed to this problem. Boddie (1957) considered various aspects of it and urged that all possible effort should be made to secure a vaccine of uniformly low irritant character.

So far it is not clear what factors contribute to the irritant reactions, but we considered that it should be possible to prepare a non-irritant product without loss of antigenicity by adapting the methods of purification used in preparing tetanus and diphtheria prophylactics.

This paper is divided into two parts : Part I describes the preparation of the product and its examination under field conditions to verify its safety and potency in different categories of sheep ; Part II describes an evaluation of the efficacy of the purified toxoid given to the pregnant ewe, for the purposes of actively immunising the ewe, of transferring the maternal immunity to the offspring, and of studying the effect such passively acquired antitoxin has on the subsequent injection of purified toxoid.

Part I

Material and Methods

Purified Toxoid

The product was basically a cell-free bacterial toxoid prepared from a highly toxigenic strain of *Cl. welchii* type D and trypsin treated to ensure full antigenicity (Batty & Glenny, 1948). The crude toxoid had been fractionated with ammonium sulphate and dialysed to remove ammonium sulphate and the resultant concentrated toxoid adsorbed on to aluminium hydroxide gel.

The concentrate before adsorption had an activity of 12,000 flocculating units per mg. of protein nitrogen, compared with 2,500 units in the original toxoid. The final product was adjusted to a total of 60 flocculating units per ml. and a *p*H of 6·5. It had a total nitrogen content of 4·1 mg. per 100 ml., compared with 450 mg. per 100 ml. of the original toxoid when this was also adjusted to 60 flocculating units per ml. Henceforth it is referred to as purified toxoid aluminium-treated*. Unpurified toxoid aluminium-treated was also prepared. This material was prepared from the same batch of crude toxoid as the purified toxoid aluminium-treated. It was trypsin-treated before adsorption on to the same concentration of aluminium hydroxide at the same *p*H and temperature, the original volume having been adjusted with buffered saline to give the same number of flocculating units per ml. as in the purified toxoid aluminium-treated.

Animals

Preliminary tests on laboratory animals for safety and potency proved satisfactory, and the purified toxoid aluminium-treated was then issued for field trial in the spring of 1957. Approximately 7,000 lambs and 250 yearling ewes in East Anglia and 1,160 lambs in Wiltshire were injected, 22 flocks being used. The injections were as a rule made by the veterinary surgeons collaborating in this work. The lambs, except some 850 injected at birth, were 3 to 4 weeks old at the time of their first injection. Most lambs received 2 injections each of 2 ml. of purified toxoid aluminium-treated, the second injection 3 to 5 weeks after the first. All injections were given subcutaneously, various sites of the body being used, *e.g.* behind the shoulder and inside the thigh.

Out of the above 8,410 animals 137 lambs, distributed throughout the various flocks, and 10 yearling ewes were selected at random and marked for individual identification and examination. Blood samples from these animals were taken before the first injection, before the second injection and 2 to 5 weeks after the second injection. As the flocks were normal commercial breeding flocks accepted at random, the ewes in some of them had been injected with pulpy kidney vaccine during pregnancy ; in a few flocks lamb dysentery or pulpy kidney serum had been given to the lambs at birth in accordance with normal practice ; in others it appeared that many of the ewes had probably acquired natural immunity, this being reflected in the titres of the pre-injection samples. None of the yearling ewes had been previously vaccinated. In one flock whose ewes had been immunised during pregnancy a comparison was carried out between purified toxoid aluminium-treated and the unpurified toxoid described above. Two groups of 30 lambs were injected at approximately 3 to 4 weeks old and again 4 weeks later with 2 ml. of the respective preparations. Blood from 10 lambs in each group was sampled as in the flocks receiving injections of purified toxoid aluminium-treated.

Results

All blood samples were titrated in mice for the content of *Cl. welchii* ϵ-antitoxin per ml. serum, at approximately twofold dilutions and by the methods of Batty & Glenny (1947). The L+/10 and L+/100 doses of the test toxin used throughout all the work described here were exactly known. Both test toxin and toxoid were continuously checked against standard antitoxin. For the purpose of this and subsequent work we accepted a minimum figure of 0·2 units ϵ-antitoxin per ml. serum as the immune level.

Table I gives the results obtained. Of 147 animals injected twice with 2 ml. of purified toxoid aluminium-treated, 59·8 per cent. were immune before the first injection, having presumably acquired these titres passively at birth from either maternal antibody or by being injected with serum, 87·4 per cent. of 127 animals were immune after 1 injection and 100 per cent. were immune after 2 injections.

* "Saffelin" : Glaxo Laboratories Ltd.

TABLE I
ANTITOXIN TITRES OF SHEEP AND LAMBS AFTER TWO INJECTIONS OF 2 ML. PURIFIED TOXOID ALUMINIUM-TREATED (P.T.A.T.)
SPRING 1957

AVERAGE AGE OF LAMBS AT TIME OF FIRST SAMPLE 3 TO 4 WEEKS
TITRES IN ALL TABLES ARE GIVEN AS UNITS ε-ANTITOXIN PER ML. SERUM

Titre before 1st injection of P.T.A.T.	Titre after 1 injection of P.T.A.T.				Titre after 2 injections of P.T.A.T				
	<0·2	0·2-2	2-20	Total	<0·2	0·2-2	2-20	>20	Total
<0·2	7	32	7	46	0	20	38	1	59
0·2-2	9	49	4	62	0	37	32	0	69
2-20	0	17	2	19	0	13	6	0	19
Total Lambs	16	98	13	127*	0	70	76	1	147*
Per cent. of Total	12·6	77·2	10·2	100·0	0	47·6	51·7	0·7	100

Ten lambs and 10 yearling ewes were not sampled after their first injection of P.T.A.T., which accounts for the difference in the columns of total animals marked*.

TABLE II
ANTITOXIN TITRES OF LAMBS, BORN TO IMMUNISED EWES, INJECTED WITH UNPURIFIED TOXOID (ALUMINIUM-TREATED) COMPARED WITH LAMBS INJECTED WITH PURIFIED TOXOID ALUMINIUM-TREATED (P.T.A.T.)
SPRING 1957

Groups of Lambs	Before first injection				Before second injection				After two injections				Total lambs in group
	<0·2	0·2-2	2-20	Mean titre	<0·2	0·2-2	2-20	Mean titre	<0·2	0·2-2	2-20	Mean titre	
Injected with unpurified toxoid	2	4	4	0·97	0	9	1	0·85	0	8	2	1·28	10
In same flock but injected with P.T.A.T.	2	5	3	0·85	0	7	3	1·13	0	5	5	2·15	10
In other flocks and injected with P.T.A.T.	4	14	11	1·06	1	24	4	0·86	0	15	14	1·92	29

Average age at time of first samples : 3 to 4 weeks.

Table II gives the results obtained in the flock in which the comparison was carried out between purified toxoid aluminium-treated and the unpurified toxoid. This shows no loss of antigenicity on purification.

Throughout this work close attention was paid to local and systemic reactions and the causes of death of any animals in the flocks were investigated. No local or systemic reaction was reported and no complaint was received from abattoirs on slaughtering of lambs involved in these trials. Lambs examined by ourselves showed little evidence of reaction and on slaughter only occasionally could any trace of reaction be seen at the site of injection. During the ensuing 4 months 15 deaths were reported, but none was diagnosed as due to pulpy kidney disease by the Veterinary Investigation Centres for the areas where the flocks were situated.

Batty *et al.* (1954) indicated that lambs having initial titres of total passive antitoxin greater than that amount required to neutralise 2½ times the total amount of antigen injected will show interference to the first injection of toxoid ; if the initial levels are very high the interference effect may still be evident at the second injection. Our results are similar to theirs.

Although best responses appeared to be in lambs with low initial levels of antitoxin, *i.e.* less than 0·2 units of antitoxin per ml. of serum, consideration of the overall responses led us to conclude that the method of immunisation rendering the greatest proportion of lambs immune at any time throughout

TABLE III
ANTITOXIN TITRES IN LAMBS AFTER 2 INJECTIONS OF 2 ML. PURIFIED TOXOID ALUMINIUM-TREATED (P.T.A.T.) BUT GROUPED ACCORDING TO SOURCE OF PASSIVELY ACQUIRED ANTITOXIN : SPRING 1957

NUMBERS AND PERCENTAGE OF LAMBS IMMUNE, I.E. HAVING MORE THAN 0·2 UNITS ε-ANTITOXIN PER ML. SERUM

Number of lambs	Before first injection of P.T.A.T.	After 1 injection of P.T.A.T.	After 2 injections of P.T.A.T.
Born of non-immunised ewes (78 lambs)	40 (51 per cent.)	65 (83 per cent.)	78 (100 per cent.)
Born of immunised ewes (39 lambs)	33 (85 ,, ,,)	38 (97 ,, ,,)	39 (100 ,, ,,)
Immunised at birth with antiserum (20 lambs)	12 (60 ,, ,,)	8 out of 10 (80 per cent.)	20 (100 ,, ,,)

Average age at time of first sample 3 to 4 weeks

the period of observation was by injecting lambs born to immunised ewes with purified toxoid aluminium-treated at about 4 weeks old.

Table III illustrates this clearly and indicates the possibility that lambs going for early slaughter at say 12 to 16 weeks old might remain immune for the whole of this period, having had only 1 injection of purified toxoid aluminium-treated at 4 to 5 weeks of age to reinforce actively the passive antitoxin acquired at birth from their mothers.

From these results it appeared that purified toxoid aluminium-treated was both a satisfactory and a safe antigen against *Cl. welchii* type D enterotoxaemia in lambs, there being apparently little risk of local or systemic reaction.

Part II

Since enterotoxaemia in sheep and lambs due to *Cl. welchii* type D can occur at any time of the year, methods of establishing and maintaining an adequate level of circulating ε-antitoxin in such animals are of considerable economic importance. It seemed necessary to us to elaborate a pattern of immunisation requiring the minimum number of injections of toxoid but at the same time maintaining a continuous level of immunity throughout the entire flock. As the results obtained in the spring of 1957 had indicated a possible satisfactory method, further experimental work was carried out in the winter of 1957 and the spring of 1958.

Material and Methods

Animals

For this work the flock maintained at the Royal Veterinary College Field Station was used. This flock comprised 67 half-bred (Border Leicester × Cheviot) ewes, most of which had been immunised in a previous pregnancy with a "Mixed Enterotoxaemia Vaccine (*Cl. welchii* types C and D)." There were, however, a number of ewes, bought in during the preceding autumn, whose previous immunisation history was unknown.

All ewes were individually marked and all bloods were sampled early in pregnancy. Titration of serum from these samples showed that the flock could be divided into two parts—Group A, of 46 ewes, all of which had at least 0·2 units ε-antitoxin per ml. of serum, and Group B, of 21 ewes, all of which had less than 0·2 units per ml. of serum, many in fact having less than 0·04 units per ml.: most of the latter ewes were those bought in the preceding autumn.

All Group A ewes were injected 3 weeks later with 2 ml. of the same batch of purified toxoid aluminium-treated as in the work reported in Part I. Group B ewes received no injections, the purpose being to widen the margin of antitoxin titres between the 2 groups of ewes.

Lambing began in February, about 4 weeks after the injection of purified toxoid aluminium-treated, and the procedure adopted was to visit the flock every alternate day, and to mark individually all lambs (whether born to Group A or Group B ewes), blood samples being taken from both lambs and their mothers. Six weeks after the lambing began, when birth recording was discontinued, 42 Group A ewes had lambed 68 live lambs (1 ewe had died and 1 ewe had lambed 2 dead lambs). In the same period 17 Group B ewes lambed 26 live lambs (1 ewe had died and 1 ewe had 1 dead lamb). None of these losses was diagnosed as due to pulpy kidney disease, and it was evident that the injection of purified toxoid aluminium-treated to ewes only 4 weeks before lambing began had had no ill effects on lambing.

Owing to a severe outbreak of contagious pustular dermatitis, a number of lambs had to be withdrawn from the flock, and only 58 lambs born to Group A ewes were available for further work. These were then allocated at random into 3 sections there being 20 lambs in Section 1 and 19 in each of Sections 2 and 3. Their ages obviously varied between 3 and 6 weeks, but in all sections most lambs were 5 weeks old.

Blood samples were taken from all lambs at this time, and lambs in Sections 1 and 2 each received an injection of 2 ml. of purified toxoid aluminium-treated. Blood samples were taken again 4 weeks later, and those lambs in Section 2 received a second and final injection of 2 ml. purified toxoid aluminium-treated. At fortnightly intervals 3 further blood samples were taken. During this period a number of lambs from each section were sold for slaughter on reaching satisfactory carcase weight. At the time of the last sample further blood samples were also taken from 34 Group A ewes.

Results

Serum from all blood samples was titrated as described in Part I and showed clearly :

(*a*) That all Group A ewes had responded well to the single injection of purified toxoid aluminium-treated. Their mean titre of units of ε-antitoxin per ml. serum rose during pregnancy from 0·49 units before injection to 2·97 units at lambing, the interval between injection of purified toxoid aluminium-treated and lambing ranging from 4 to 7 weeks.

(*b*) Ewes injected during pregnancy with purified toxoid aluminium-treated transferred satisfactory levels of antitoxin to their lambs these having at birth a mean titre of 7·44 units per ml. of serum.

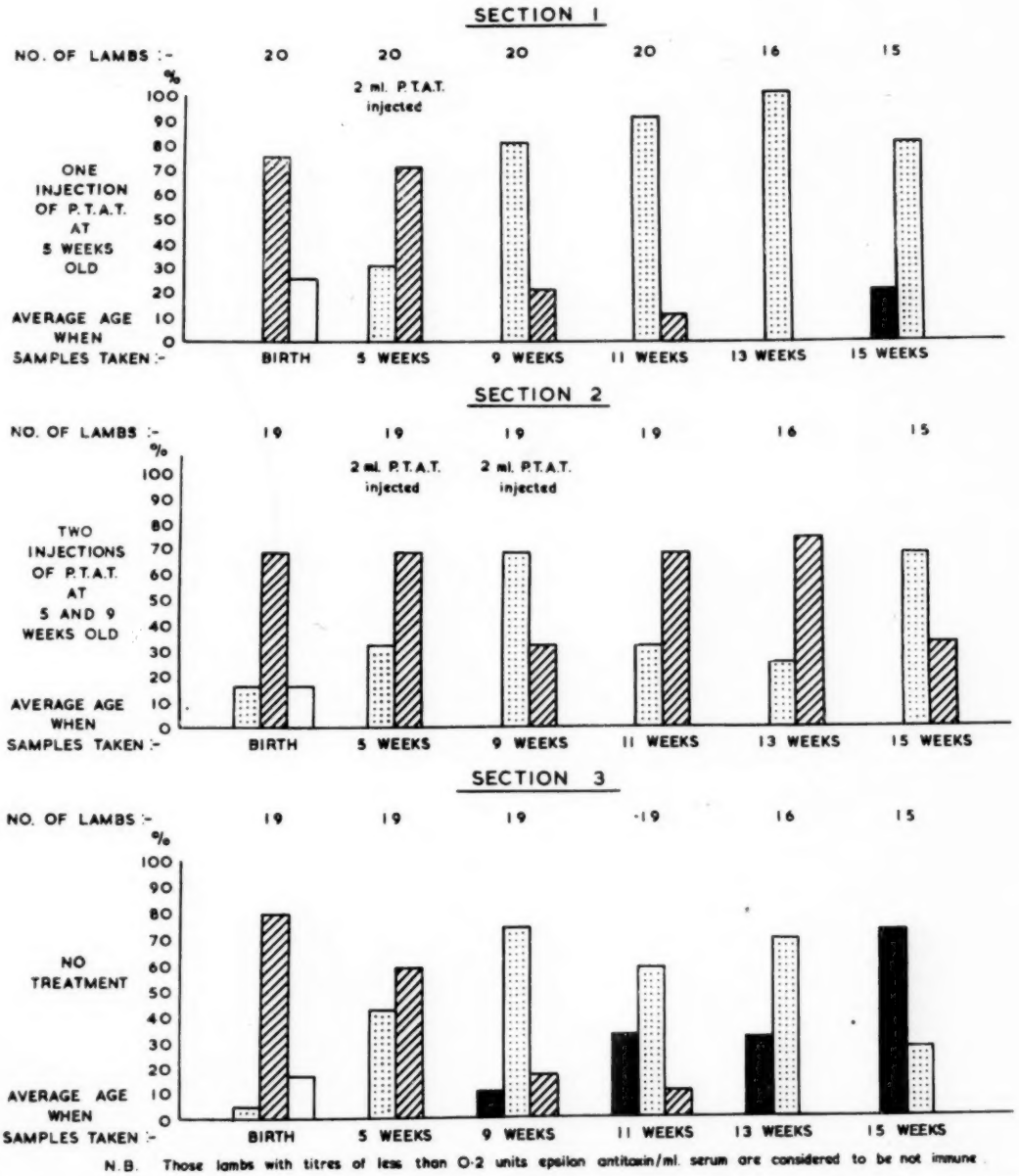
(*c*) Nineteen weeks after the booster injection of purified toxoid aluminium-treated, 34 Group A ewes still had a mean titre of 1·58 units per ml. of serum.

All ewes in Group B (no injections) and their lambs had titres of antitoxin below the required immune level (*i.e.* less than 0·2 units per ml. of serum).

Antitoxin titres of the lambs born to Group A ewes then fell gradually, more or less at the rate calculated by Barr, Glenny & Howie (1953) for the exponential loss of passive homologous antitoxin—that is 16 per cent. per week. It should be remembered, however, that these lambs had certainly doubled, and in some instances trebled, their birth-weights and total blood volumes by 5 weeks of age.

Table IV and the figure show this in more detail. It was noteworthy that all 58 lambs were still immune at 5 weeks old. The loss of antitoxin continued steadily in the non-injected Section 3 lambs ; at 9 weeks of age 10 per cent. of them were no longer

TITRES OF ε ANTITOXIN/ML. SERUM IN LAMBS BORN TO EWES INJECTED DURING PREGNANCY WITH P.T.A.T. (SPRING 1958)



N.B. Those lambs with titres of less than 0·2 units epsilon antitoxin/ml. serum are considered to be not immune.

KEY			
NOT IMMUNE	IMMUNE		
< 0·2 units/ml.	0·2 - 2 units/ml.	2 - 20 units/ml.	> 20 units/ml.

(See Table IV overleaf)

TABLE IV
ANTITOXIN TITRES OF LAMBS BORN TO EWES INJECTED DURING PREGNANCY WITH P.T.A.T. AND THEN RECEIVING VARIOUS TREATMENTS AFTER BIRTH : SPRING 1958

Titre	Section 1—One injection P.T.A.T. at 5 weeks of age						Section 2—Two injections P.T.A.T. at 5 and 9 weeks of age						Section 3—No treatment					
	Samples						Samples						Samples					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
<0·2 (not immune)	0	0	0	0	0	3	0	0	0	0	0	0	0	0	2	6	5	11
0·2–2	0	6	16	18	16	12	3	6	13	6	4	10	1	8	14	11	11	4
2–20	15	14	4	2	0	0	13	13	6	13	12	5	15	11	3	2	0	0
>20	5	0	0	0	0	0	3	0	0	0	0	0	3	0	0	0	0	0
Mean titre	13·17	2·98	1·02	0·83	0·46	0·32	8·13	2·05	1·34	2·9	2·42	1·4	7·42	1·91	0·58	0·35	0·27	0·11
Weeks old (average)	0	5	9	11	13	15	0	5	9	11	13	15	0	5	9	11	13	15
No. of lambs	20	20	20	20	16	15	19	19	19	19	16	15	19	19	19	19	16	15

immune, at 11 weeks and 13 weeks approximately 31 per cent. were not immune and at 15 weeks 73 per cent. were not immune.

Lambs that had received a single injection of purified toxoid aluminium-treated (Section 1) given at an average of 5 weeks old showed that the loss of antitoxin was slowed down considerably, the loss of passive antitoxin being partly balanced by the development of actively produced antitoxin, and even at 13 weeks old 100 per cent. of these lambs were still immune. However at 15 weeks old 20 per cent. were no longer immune.

Lambs that had received injections of purified toxoid aluminium-treated at an average of 5 and 9 weeks old showed a similar check in the loss of antitoxin from one injection with a satisfactory response to the second injection. At 15 weeks old all were still well immunised.

Discussion

Our experiments demonstrated the possibility of using purified toxoid aluminium-treated to stimulate and maintain a satisfactory level of circulating *Cl. welchii* ϵ-antitoxin in pregnant ewes, so that the lambs born of immunised ewes received high levels of ϵ-antitoxin at birth *via* their mothers' colostrum (Mason, Dalling & Gordon, 1930). All these lambs were still immune at 5 weeks old.

In 19 lambs which did not receive the active immunisation stimulus of an injection of purified toxoid aluminium-treated, there was a steady fall in their passively acquired antitoxin titres so that 31 per cent. were not immune at 13 weeks and 73 per cent. were not immune at 15 weeks old.

However the use of a single injection of purified toxoid aluminium-treated given at 5 to 6 weeks of age to such lambs showed that it was possible to actively reinforce the falling titre of passive antitoxin and so to extend the period of immunity in these lambs until they were all 13 weeks old, only 20 per cent. being not immune at 15 weeks.

It was therefore noteworthy that, whereas in Section 3 (which were not injected with purified toxoid aluminium-treated) 10 per cent. of the lambs were not immune at 9 weeks of age, all the 39 lambs in Sections 1 and 2 were immune at this time after the use of only 1 injection of purified toxoid aluminium-treated at 5 weeks of age.

The use of a second injection of purified toxoid aluminium-treated, 4 weeks after the first, produced a good secondary response and well immunised all the lambs in Section 2.

These results confirm the evidence gained from the previous year's field trial that a high proportion of lambs born to ewes immunised during pregnancy against pulpy kidney disease and then themselves actively immunised with purified toxoid aluminium-treated at about 5 weeks of age would still be immune at 3 months of age. Batty *et al.* (1954), in recommending methods of active immunisation of lambs immediately after birth, commented on this possible method of immunising lambs, but thought it probably the least certain of the methods they suggested, for they considered that, if the active immunisation of lambs born to immunised ewes were delayed until 5 to 6 weeks of age, these lambs might be at risk before the development of a sufficiently high level of circulating antitoxin at least 3 to 4 weeks later. When toxoid was injected at birth to lambs born to immunised ewes, they emphasised the importance of leaving a sufficiently long interval between the first and second injections of toxoid. This interval would lower the degree of interference from the lamb's passively acquired antitoxin.

Although it was not possible for us to vary the interval between the 2 injections of purified toxoid aluminium-treated, all our evidence indicates that in fact the method of waiting until 5 weeks of age before giving the first injection of purified toxoid aluminium-treated to lambs born to immunised ewes is entirely safe and gives such lambs an adequate level of protection in the period between the 2 injections. Since only 10 per cent. of the lambs in Section 3 were not immune at 9 weeks of age, it seems unlikely that the titres of lambs in Sections 1 and 2 would have fallen below the immune level during the interval from 5 to 9 weeks of age, only to rise above this level by 9 weeks. It appears more probable that the fall in the titre of their passive homologous antitoxin was countered by the rise in titre of actively produced antitoxin.

(*Continued on opposite page*)

Clinical Notes

A Case of Spontaneous Rupture of the Bovine Uterus

K. G. Morgan

Chepstow

SUMMARY.—A case of spontaneous rupture of the bovine uterus described with its surgical repair and the subsequent recovery of the animal.

THE subject of this note was a cross-bred Friesian cow, about 7 years old, calving for the 4th time. The animal calved unaided out of doors delivering a large, live Hereford-cross calf and developed milk fever immediately. After early routine treatment the cow got up, walked home, and was housed in a loose-box. At this time she had not passed her placenta which was much in evidence, almost touching the ground.

The next morning the owner reported that the cow was again recumbent and requested a further visit. On examination the animal was found to be down with a subnormal temperature, rumenal stasis, a somewhat distended abdomen, and a frequent, painful type of grunt.

It was not considered that her condition was completely typical of milk fever but further calcium treatment was given as a precautionary measure. Two hours later the animal was standing, she was still very depressed and completely constipated, and her temperature was still subnormal. Symptomatic treatment was given and every effort was made to encourage the animal to feed.

On the 3rd day the condition remained the same except that small amounts of dark-coloured liquid faeces were voided fairly frequently with an abnormal degree of straining and a good deal of painful grunting. Rumenal stasis was complete and there was some degree of tympany.

On the following day the animal was acutely ill and it was suggested to the owner that as the condition was vaguely suggestive of the presence of a penetrating foreign body an exploratory laparotomy might help to elucidate the situation. Accordingly a routine rumenotomy was performed and it was found that no foreign body was present in the reticulum, neither was there any evidence that one had recently penetrated. The rumen was then closed and a manual examination was made of the abdominal viscera within reach. It was found that there was a considerable amount of straw-coloured fluid present and, low down on the left side, a soft mass suggesting semi-solid exudate was palpated. This could be detached from the abdominal wall and was drawn up into the incision for visual inspection when it proved to be a partly decomposed piece of afterbirth about 2½ feet long, which was free in the abdominal cavity. It thus became obvious that a uterine rupture must be present and also that it would be impossible to deal with it through an incision so far removed from the affected organ. Accordingly the wound was closed, the skin sutured, and a second incision was made low down in the left flank as if to perform caesarean section in the standing position. Although the cow had been calved for several days, no difficulty was found in exteriorising the uterus and an irregular tear about 4 inches in length was found towards the tip of the greater curvature of the left horn. The edges had become everted and several cotyledons protruded into the abdominal cavity. The edges of this tear

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Immunisation of Lambs—*Concluded.*

As a result of these observations it appears that the most satisfactory method of establishing and maintaining an adequate level of circulating *Cl. welchii* ε-antitoxin in all animals of a breeding flock of sheep is to establish immunity in the ewe by injections of toxoid during pregnancy (2 injections to animals not previously immunised, 1 injection to animals immunised in a previous pregnancy or as lambs), the second or single injection being given preferably within the last month of pregnancy, and then to begin active immunisation of their lambs at about 5 weeks of age. If early disposal of the lambs at about 3 months of age for slaughter is practised, such animals could safely be regarded as immune after only 1 injection of toxoid at 5 weeks of age. Lambs being kept for later feeding and fattening, or as breeding flock replacements, should receive a second injection of toxoid, but not before 4 weeks after the first injection. Subsequently they would require only a single injection of toxoid to reinforce this immunity, or to act as the annual "booster" injection during pregnancy in the ewe.

Acknowledgments.—Grateful acknowledgments for much valuable help in this work are made to the many veterinary surgeons and Veterinary Investigation Officers who collaborated with us in Spring 1957, and to Dr. R. E. Glover and the Council of the Royal Veterinary College who kindly placed the ewe flock at their Field Station at our disposal for our work in 1958 and also to the staff of the Field Station.

We also thank Dr. M. Hilton and Mr. R. B. French for much help with the serum titrations and Miss M. Barr of the Wellcome Research Laboratories for the supply of standard antitoxin.

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were trimmed with scissors and the wound closed with No. 4 catgut with first a continuous suture which was then turned in with a row of interrupted sutures. The surface of the uterus was dressed with intramammary penicillin, 2 chlortetracycline tablets* were placed low in the abdominal cavity, and the wound was sutured using No. 4 catgut for the musculature and nylon for the skin.

The cow was visited daily for the next 4 days and was given 5 mega units of crystalline penicillin at each visit.

Recovery was slow but uninterrupted and there was a sufficient milk yield to feed a large thriving calf. Healing was by first intention and the sutures were removed on the 10th day when the patient was feeding and cudding normally. Milk yield increased to a maximum of about 4 gallons (unrecorded) and bodily condition improved.

Discussion

The apparent rarity of this case is the reason for this recording and it is interesting to postulate the cause of a uterine tear, which, prior to involution, must have been of some considerable magnitude.

The major portion of the placenta was voided in the normal way so that the owner reported that the animal had "cleansed normally."

It is also interesting to note that the temperature remained subnormal until after the uterus was repaired although there was considerable peritoneal infusion which could hardly have been sterile.

* Aureomycin "Oblets."

A Note on Haemorrhagic Septicaemia in Neonatal Pigs

B. L. Edwards

Veterinary Investigation Centre, Redhill, Worcester

SUMMARY.—A condition is described in neonatal pigs characterised at post mortem *by serous effusions and haemorrhages and associated with the recovery in almost pure culture of an unusual strain of* Pasteurella.

Introduction

HAEMORRHAGIC septicaemia associated with *Pasteurella multocida* infection is well known in cattle and is readily reproduced in experimental animals (Topley & Wilson, 1956). The same organism is frequently isolated from pigs, particularly from pneumonic areas of the lungs but there does not appear to be any previous record of its occurrence as a generalised infection in newly-born piglets.

Clinical History

Two dead pigs of 3 days of age and 1 stillborn were submitted for *post mortem* and bacteriological examination. Only 1 piglet in this litter remained alive out of 7. Three other litters lost 3 piglets each, and over-all there had been a mortality of 24 piglets out of 63. The illness lasted 12 hours before death. Further deaths occurred subsequently and although mortality ceased following the introduction of sulphadimidine therapy, the farmer gave up pig-keeping.

Post-mortem Examination

All the specimens weighed between 3 and 4 lb., and the stomachs of the first 2 were full of clotted milk. The third one showed the typical appearances of stillbirth, in addition to which there was subcutaneous haemorrhagic oedema and an excess of blood-stained serous fluids. None of the specimens showed any evidence of trauma.

The first 2 piglets revealed marked excess of serous fluids, patchy haemorrhagic consolidation of the lungs, and extensive epicardial haemorrhage.

Cultural Examination

The stillborn piglet produced no organisms of significance. In the viable piglets the findings were strikingly unusual. Inocula from all sites on 5 per cent. sheep-blood agar produced an almost pure growth of small translucent mucoid and slightly haemolytic colonies. On MacConkey's medium, however, there was either no growth or a few large lactose-fermenting colonies. Smears of the organism on blood agar showed it to be bipolar and gram-negative. On standing on the bench the morphology became filamentous with loss of bipolarity.

On intraperitoneal inoculation a mouse died at 18 hours and bipolar organisms were identified in the heart blood. The organism was fairly sensitive to penicillin, streptomycin, and erythromycin, and very sensitive to chloramphenicol* and chlortetracycline† using "Sentest" tablets.

Cultures were submitted to Dr. M. A. Soltys since the organism appeared to be unusual. It was identified as resembling *Pasteurella haemolytica*. However, it differs from the strain described by Campbell, Campbell, and Dromey (1949) in the following respects. It produced no growth in MacConkey's medium, acid in lactose, and slight acid in litmus milk. In addition it produced hydrogen sulphide and was penicillin sensitive. The principal feature distinguishing it from *Pasteurella multocida* lay in its being non-lethal to mice by subcutaneous inoculation.

Acknowledgments.—I am indebted to Dr. M. A. Soltys (Department of Animal Pathology, University of Cambridge) for confirmation and extension of the bacteriological findings, and Mr. W. W. Williams for routine technical facilities.

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* Chloromycetin.

† Aureomycin.

Studies on Lungworm Infection of Pigs. III.—The Progressive Pathology of Experimental Infections

BY

A. MACKENZIE

A.R.C. Field Station, Compton, Berkshire

SUMMARY.—1. *The progressive pathology of experimental lungworm* (Metastrongylus elongatus) *injection of pigs is described from experiments in which* 22 *young pigs were infected with single large initial doses of larvae and were subsequently killed for examination at intervals of from* 1 *to* 80 *days after infection.*

2. *The symptoms of the infection are correlated with the development of the parasites and the pathological changes produced at various phases of the disease.*

3. *A growth curve for male and female* M. elongatus *is presented from the data obtained from developing lungworms that were recovered from the experimental animals at various intervals after infection.*

4. *The chronological development of the histopathological changes seen during the infection is followed up to* 80 *days after infection when all the features of the chronic disease are present. Four main types of reaction are recognised that could contribute to the production of pulmonary consolidation at different stages,* viz. *eosinophil leucocyte infiltration, mononuclear and giant-cell reaction, coalescing eosinophil nodules, and peribronchial lymphoid hyperplasia.*

Introduction

IN two previous .communications (Mackenzie, (1958a, b) observations were reported on the lesions occurring in natural pig lungworm infections and on the character and distribution of the lung lesions produced in the early patent phase of experimental infections. In the latter it was shown that the administration of small doses of infective Metastrongyle larvae resulted in the localisation of adult lungworms in the diaphragmatic lobes of the lungs which is the distribution characteristic of light natural infections. The administration of larger initial doses of infective larvae produced more disseminated infections of the lungs in which the anterior lobes were also involved and in these cases marginal consolidation of the anterior lobes was often produced. The gross and microscopical appearances of the changes found in the lungs of pigs during the early patent period of infection differed in some respects from those commonly seen in the end-stages of the disease. The following observations were subsequently made on experimentally infected pigs in order to follow the progressive pathology of the disease through all stages of infection.

Materials and Methods

In the main experiment 14 pigs, 8 weeks of age, were given oral doses of 4,000 infective larvae of the pig lungworm *Metastrongylus elongatus* and were subsequently killed for examination from 1 to 80 days after infection at intervals indicated in Table I. Seven undosed pigs from the same group were kept as controls. In Experiment II, 5 pigs, 10 to 13 weeks old, were infected with doses of 2,000 larvae and were killed after periods of 3, 5, 7, 10, and 15 days, while 1 animal kept as a control was slaughtered after 15 days. In the third experiment 3 further young pigs were each infected with 2,000 larvae and killed at intervals of 14, 21, and 35 days after dosing.

The source, preparation, and administration of the infective lungworm larvae was the same as employed in previous experimental studies (Mackenzie, 1958b) in which doses of 4,000 and 2,000 larvae were found to produce lungworm infections that extended to all lobes of the lungs. The average age of the infective larvae used in the present experiments was about 85 days.

During the course of the experiments clinical inspections of the animals were made daily and in the third experiment this included daily recordings of the rectal temperature. Blood and faeces samples were taken at intervals of 5 days up to 50 days after infection and subsequently at intervals of 10 days. The animals were weighed at similar intervals. Faeces were examined for the presence of lungworm eggs by the McMaster flotation method and by centrifugation using a saturated solution of magnesium sulphate (Dunn & White, 1954). Haematological examination included estimations of the total white cell count using the standard method, differential leucocyte counts on methyl alcohol-fixed smears stained by Leishman-Giemsa and circulating blood eosinophil counts using the counting chamber method after Randolph (1949) with the eosinophil staining solution of Farrington and Jetter (1953).

At *post-mortem* examination various tissues were examined for the presence of migrating lungworm larvae during the early stages of the disease. The parts examined were small and large intestine, hepatic, mesenteric, ileo-caecal and colic lymph nodes, liver, lungs, and bronchial lymph nodes. The parasitological methods used included microscopical examination of direct smears, squeezed and minced preparations of tissues, separation of motile larvae from tissues set up in the Baermann apparatus and recovery of larvae after pepsin digestion. Immature lungworms in the lungs were recovered by washing the opened bronchi and compressing the lung tissue in normal saline, followed by sedimentation of the washings in round-bottomed glass tubes, 6 inches by 1 inch in size.

Bacteriological and histological examinations were carried out as in earlier studies. Eleven different

regions of the lungs were examined histologically together with samples from the bronchial lymph nodes, small and large intestine, hepatic, mesenteric, ileo-caecal and colic lymph nodes, liver, spleen, kidney, and heart.

Results

Clinical Examination

Regular clinical inspection revealed that coughing, which was the main symptom at the levels of infection employed in the experiments, usually commenced 10 to 13 days after dosing. It appeared as short, sporadic bouts of husky coughing that were most readily observed after running the pigs round the pen. This symptom was pronounced at about 4 to 5 weeks after infection but later became more infrequent, and in the 2 animals with infections of the longest duration it was not observed later than 55 days after infection. The character of the respirations of infected animals while at rest appeared to be normal but occasionally slight dyspnoea appeared in individuals after exercise round the pen. No significant rises in temperature occurred in the 3 pigs of the third experiment in which the daily rectal temperatures were recorded. Throughout the course of the experiments the appetite of infected animals compared with controls appeared to be normal and no significant differences were detected in the weight gains of those in the infected and control groups during the experiments.

The only significant haematological finding was a rise in the numbers of circulating blood eosinophil leucocytes in the infected pigs. This rise was not large enough to influence the total white cell count and the rest of the differential leucocyte count remained within the normal range. The average numbers of circulating blood eosinophils (counting chamber method) in infected and control animals up to 40 days after infection are shown in Fig. 1. The rise in the eosinophil count commenced about 10 to 15 days after infection, reached a peak around 25 days and returned to normal by about the 35th day.

Embryonated lungworm eggs were first detected in the faeces of infected pigs in the samples taken

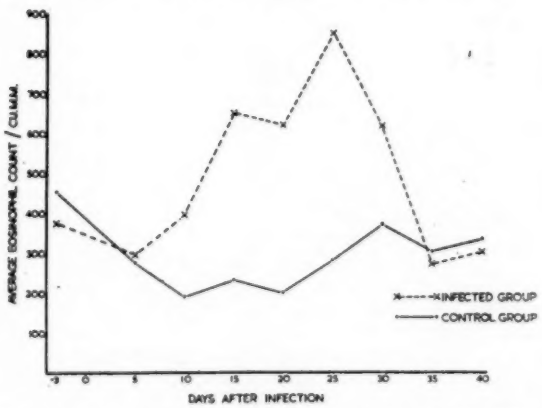

FIG. 1.—Average numbers of circulating blood eosinophils in infected and control pigs in the experiments at intervals up to 40 days after infection.

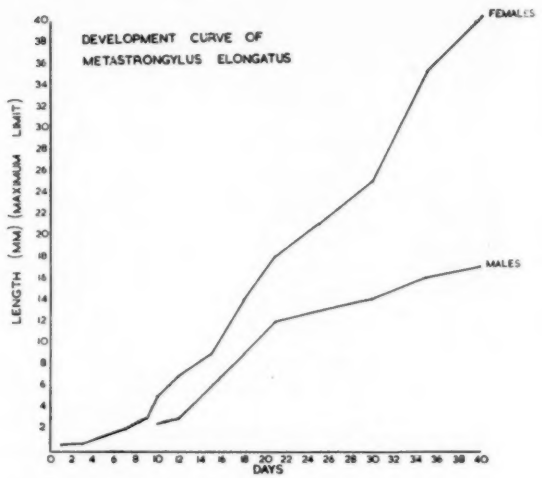

FIG. 2.—Development curve of male and female *Metastrongylus elongatus* recovered from experimentally infected pigs at intervals up to 40 days after infection.

30 days after infection. Positive worm egg counts were obtained in infected pigs until they were killed and in the animal killed after a period of 80 days, the highest counts were obtained between 50 and 75 days after infection.

Post-mortem Examination

Parasitology

Twenty-four hours after infection developing fourth-stage larvae (0.6 mm.) were recovered in pepsin digest preparations from the wall of the caecum and the anterior part of the colon of an infected pig. From pigs killed at 3 and 5 days more numerous fourth- and fifth-stage larvae up to 0.75 mm. in length were found in the ileo-caecal and colic lymph nodes while at 7 days numerous fifth-stage larvae up to 2 mm. long were recovered from the lungs. Seven-day-old larvae had developing oral papillae and straight, digitiform tails with no vulvar cuticular swelling. Rudiments of the genital system could be seen and males had distinct developing bursae. No larvae were recovered from the liver or hepatic lymph nodes during the migratory phase of the infections. Subsequently developing lungworms were found in the lungs at various intervals after infection and specimens obtained in this way were used to prepare a development curve for male and female *M. elongatus* (Fig. 2). Examinations of the uninfected control pigs were negative.

The earliest evidence of immature lungworms feeding in the lungs was seen at 9 days after infection when the parasites were about 3 mm. long. Small oral papillae were present and the digitiform tail was either straight or only slightly recurved. The intestinal canal was filled with ingested cells, mainly eosinophil and mononuclear leucocytes and red blood corpuscles. The developing ovaries and uterus could also be seen at this stage and in the male the

bursa, rays, and spicules were evident. The vulvar swelling appeared by 12 days when the worms were up to 7 mm. long, and by the 15th day the oral papillae were prominent and developing ova were situated in the uterus. The reproductive organs of the male appeared mature by the 18th day with testes, bursa, rays, and spicules all well formed. The females at this stage showed more distinct vulvar swellings and their tails were partially flexed. Embryonated lungworm eggs were first seen in female lungworms removed from the lungs 25 days after infection when the worms had attained a length of 21 mm. The attainment of complete sexual maturity in the female was reflected in the full recurvature of the tail and the increasing prominence of the vulvar cuticular swelling. The lungworms reached their full adult size by 40 days after infection.

During *post-mortem* inspection of the lungs immature lungworms were first visible to the naked eye in the finest bronchi at 12 to 15 days after infection. They were seen most readily when squeezed out in clumps in the frothy exudate present in affected lung segments. Close inspection was required to identify them at this stage as they were fine and thread-like and under 1 cm. in length. Clumps of young worms were more readily visible by the 21st day of infection and by the 25th day young mature specimens 2 cm. long were obtained from the small bronchi. Adult lungworms were usually confined to the small bronchi near the surface of the lungs where they were often surrounded by a tenacious greenish or white mucopurulent exudate.

Macroscopic Lesions

The first macroscopic changes were seen in the lungs at 12 days after infection and consisted of early vesicular emphysema accompanied by small, irregular pale-red areas of consolidation. The latter occurred along the ventral margins of the lobes and were occasionally seen on the dorsal aspect of the lungs. Similar changes were more extensive at 15 days. The distribution of these and subsequent lesions developing in the lungs is shown diagrammatically in Fig. 3. Distinct emphysema with a lobular definition was evident by the 21st day. Chronic vesicular emphysema of lung lobules caused by obstruction of the related small bronchi by adult lungworms and mucous exudate occurred in all subsequent infections.

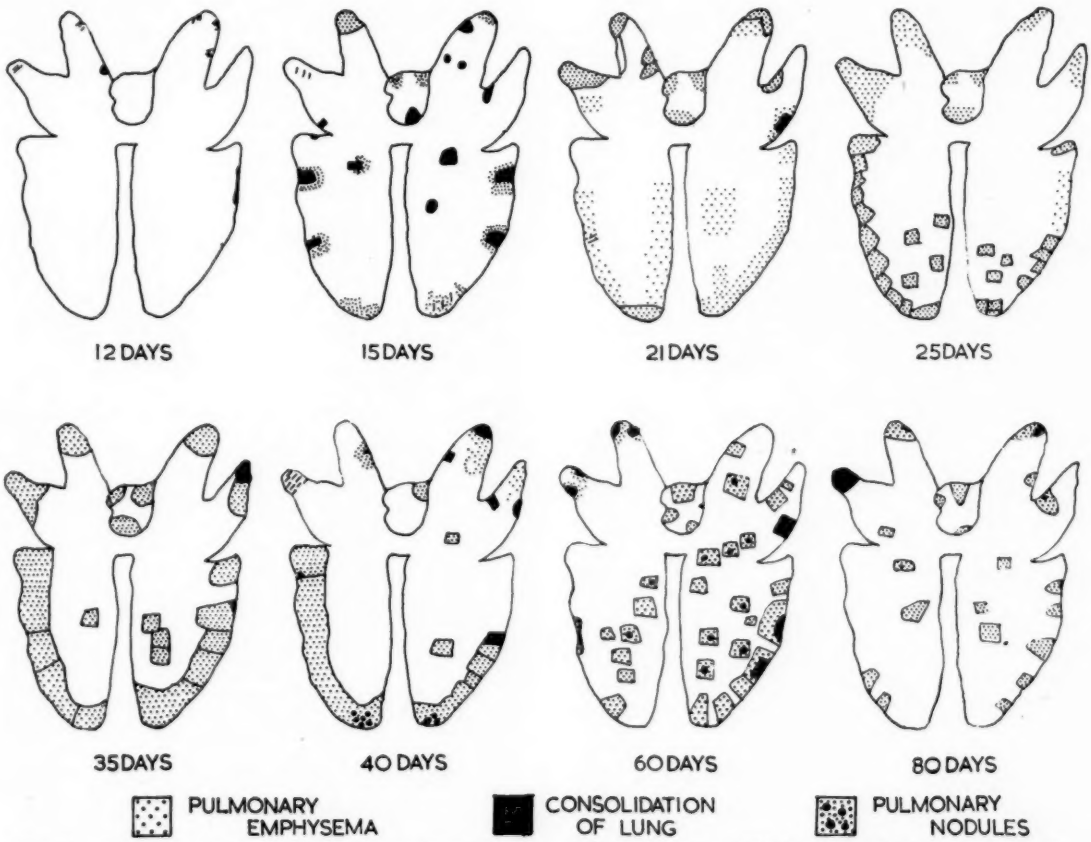

FIG. 3.--Diagrams of pig lungs from experimentally infected animals given 4,000 lungworm larvae, indicating the occurrence and distribution of the lung lesions at various intervals after infection.

At the levels of infection used all lobes of the lung were involved but the basal border and the posterior extremity of the diaphragmatic lobe were most severely affected. Fewer lungworms were found in the anterior lobes although in this situation pulmonary consolidation affecting the ventral dependant parts of the lung was most frequently seen. The most distinct consolidation during the course of the disease was seen in infections with a duration of 35 days or longer and occurred as well-defined pink or plum-red areas with a firm, moist cut-surface, usually situated in the ventral aspects of the anterior lobes or in the lower border of the diaphragmatic lobe of the lung. At 40 to 60 days after infection there were in addition small, grey, subpleural nodules about 0.5 to 2 mm. in size that occurred in lobules already affected by emphysema. These nodules were most often seen at the caudal extremity of the diaphragmatic lobe and on the dorsal surface of the lung. Their cut-surface revealed a central yellow or greenish focus surrounded by a narrow zone of firm grey tissue. Sometimes their coalescence produced small areas of granular consolidation. Pulmonary nodules situated deeper in the lung could also be palpated in the lungs of a pig killed 80 days after infection.

Enlargement of the bronchial lymph nodes was observed 10 days after infection and persisted throughout the course of the disease. No distinct lesions attributable to lungworm infections were observed in any of the other organs.

Bacteriology

Bacteriological examination of the lungs of pigs in all the experiments did not reveal any organisms of pathogenic significance associated with the lungworm lesions.

Histology

A summary of the main progressive histopathological changes that were observed in the lungs, in relation to the macroscopic appearances and clinical findings, is given in Table I.

(a) *Prepatent Stage: Larval Migratory Phase* (1 to 9 days after infection). The histopathological abnormalities seen during the larval migratory phase of infection in the present studies were confined to the lungs and bronchial lymph nodes. Examination of the alimentary canal, mesenteric lymph nodes, and other viscera revealed no significant changes in infected animals compared with controls. No migrating larvae were seen in sections of mesenteric

TABLE I
SUMMARY OF THE PROGRESSIVE CHANGES IN PIG LUNGWORM INFECTION

Observations	Days after infection	1	3	5	7	9	10	12	15
Clinical	Cough	–	–	–	–	–	++	++	+
	Eosinophilia	–	–	–	–	–	+	++	++
	Eggs in faeces	–	–	–	–	–	–	–	–
Macroscopic	Emphysema	–	–	–	–	–	–	+	+
	Consolidation	–	–	–	–	–	–	+	++
	Pulmonary Nodules	–	–	–	–	–	–	–	–
Histological	Mononuclear Reaction	–	–	+	+	+	+	++	++
	Eosinophil Infiltration	–	–	–	–	–	+	+++	+++
	Vesicular Emphysema	–	–	–	–	–	–	+	+
	Muscle Hypertrophy	–	–	–	–	–	–	–	–
	Mucoid Metaplasia	–	–	–	–	–	–	–	–
	Giant Cell Reaction	–	–	±	±	±	–	+	+
	Eosinophil Granulomas	–	–	–	–	–	–	–	–
	Lymphoid Hyperplasia	–	–	–	–	–	–	–	+

TABLE I—*continued*

SUMMARY OF THE PROGRESSIVE CHANGES IN PIG LUNGWORM INFECTION

Observations	Days after infection	18	21	25	30	35	40	60	80
Clinical	Cough	+	+	+	++	++	++	–	–
	Eosinophilia	++	++	+++	++	+	–	–	–
	Eggs in faeces	–	–	–	+	++	++	+++	+
Macroscopic	Emphysema	+	++	++	+++	+++	+++	++	++
	Consolidation	+	+	+	+	++	++	+	+
	Pulmonary Nodules	–	–	–	–	–	++	++	++
Histological	Mononuclear Reaction	++	+	+	+	+	+	+	+
	Eosinophil Infiltration	+++	+++	++	++	+	±	±	±
	Vesicular Emphysema	+	++	++	++	++	++	++	++
	Muscle Hypertrophy	+	+	+	+	+	++	++	++
	Mucoid Metaplasia	–	–	–	–	+	++	++	++
	Giant Cell Reaction	+	+	+	+	+++	+++	++	++
	Eosinophil Granulomas	–	–	–	+	+	++	+++	+
	Lymphoid Hyperplasia	+	++	++	++	++	++	++	+++

– = Absent. ± = Occasionally seen. + to +++ = Degree of change present.

A. MACKENZIE.—STUDIES ON LUNGWORM INFECTION OF PIGS

FIG. 4.—Part of a developing lungworm larva in the lungs of a pig killed 9 days after infection. There is a mononuclear cell reaction in the alveolar walls. H. and E. × 1,080.

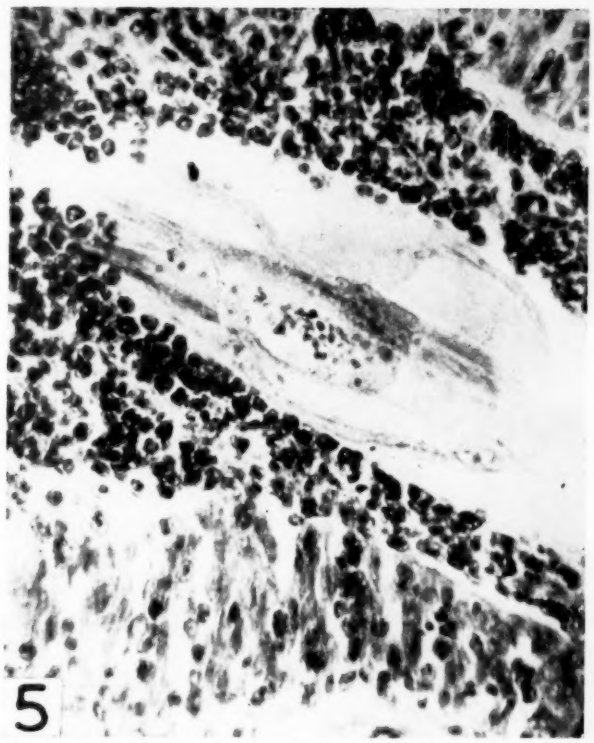

FIG. 5.—Migration of eosinophil leucocytes through the bronchiolar mucosa to produce a cellular exudate of eosinophils round the immature lungworm present in the lumen of a bronchiole at 12 days after infection. H. and E. × 1,080.

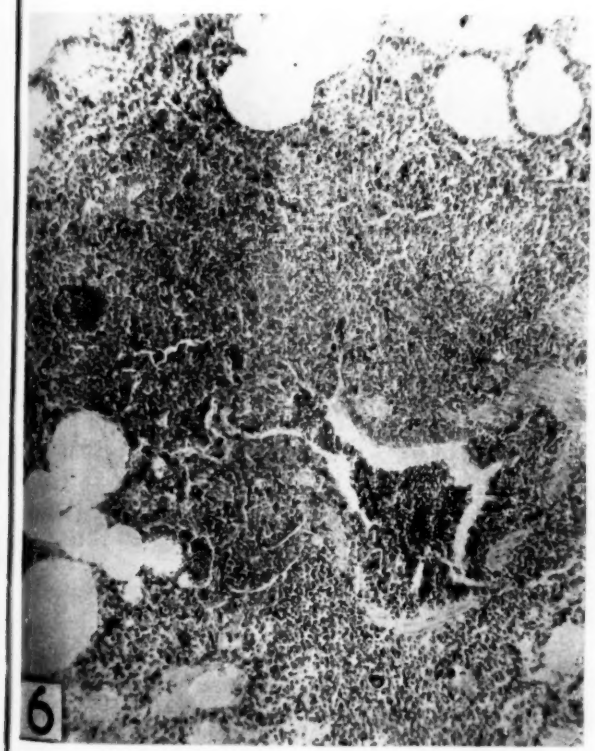

FIG. 6.—Area of pulmonary consolidation associated with dense infiltration by eosinophil leucocytes and interstitial round cell infiltration at 15 days. H. and E. × 300.

FIG. 7.—Early peribronchiolar lymphoid hyperplasia present 18 days after infection. H. and E. × 300.

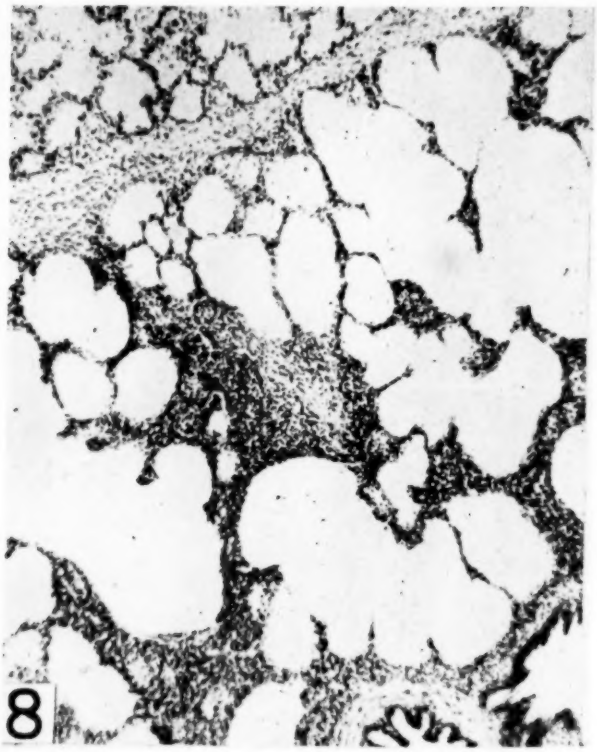

FIG. 8.—Pulmonary emphysema accompanied by interstitial round cell infiltration in an affected lobule of the lung 30 days after infection. H. and E. × 200.

FIG. 9.—Reactive pneumonia 35 days after infection with foreign-body type giant cells associated with aspirated lungworm eggs. H. and E. × 480.

FIG. 10.—Eosinophil granulomas situated in affected lobule 60 days after infection. H. and E. × 300.

FIG. 11.—Follicular lymphoid hyperplasia at 80 days with bronchiolar stenosis and disruption of the epithelium in places. H. and E. × 200.

lymph nodes from which larvae had been recovered and there were no inflammatory reactions associated with their migration. The early changes seen in the lungs at 5, 7, and 9 days after infection were associated with the migration of lungworm larvae through the lung parenchyma. At this stage there was an increase in the cellularity of the alveolar walls which was accompanied by occasional alveolar mononuclear cell exudates and some intra-alveolar haemorrhage. There was evidence of phagocytosis of red blood corpuscles by macrophages and occasional multinucleate giant-cells were seen free in the alveoli. Few larvae were seen in the sections of lung at this phase and the tissue reactions in their vicinity were usually confined to a mild mononuclear cell reaction (Fig. 4) although occasional dead larvae could be seen closely surrounded by active giant-cells. There was no visible eosinophil leucocyte reaction in the lungs up to 9 days after infection and there was no pulmonary consolidation.

(b) *Prepatent Stage: Immature Lungworm Phase* (10 to 25 days after infection). At 10 to 12 days immature lungworms were situated in the smallest bronchioles as well as in the lung parenchyma. At this stage of the infection, coinciding with the commencement of eosinophilia, there was a pronounced eosinophil leucocyte reaction in the lungs. Severe infiltration of the bronchiolar mucosa occurred and many eosinophils could be seen migrating through the bronchial epithelium to form a cellular exudate round the immature lungworms in the lumen (Fig. 5). The intestinal canals of the parasites at this stage contained ingested cells, mainly eosinophils, mononuclear cells, and red blood corpuscles. The increase in the cellularity of the alveolar walls persisted due to the presence of mesenchymal and small mononuclear cells as well as to an apparent multiplication of alveolar lining cells, in which occasional mitoses were seen. There was also some cell exudate in alveoli, composed of alveolar macrophages, lymphocytes, and eosinophil leucocytes. Some free multinucleate giant-cells were also present. Distension of alveoli in early vesicular emphysema was accompanied in affected lobules by foci of microatelectasis. At the margins of some lobes larger areas of collapse together with interstitial cellular infiltration and an eosinophil leucocyte reaction resulted in consolidation of the lung (Fig. 6).

At 2 to 3 weeks after infection the dense eosinophil leucocyte infiltration of the bronchial mucosa was most pronounced and extended in places to the interalveolar walls as well as to the connective tissue of the lungs, especially in the perivascular site and occasionally to the lung septa. Round cell infiltration was also more distinct and early peribronchial lymphoid hyperplasia was seen for the first time (Fig. 7). The commencement of hypertrophy of the bronchiolar smooth musculature was seen 18 days after infection and gradually became more distinct as the immature lungworms developed. At the same time emphysema of the affected lobules became more pronounced. Young lungworms in the bronchi were usually surrounded by a mixed cell exudate in which eosinophils were predominant and a similar exudate could be seen in some of the alveoli. The more widespread consolidation of the lung at this stage was associated with the extension of pulmonary collapse, eosinophil and round cell infiltration, early lymphoid hyperplasia, and the alveolar exudate that occurred in relation to the developing lungworms.

Sections of the bronchial lymph nodes showed that enlargement commencing 10 days after infection was associated with hyperplasia of the lymphoid tissue within the node accompanied by a dense infiltration of eosinophil leucocytes into the sinuses and trabeculae. These changes were more severe later in the disease and persisted throughout the course of the infection.

(c) *Early Patent Stage* (25 to 40 days after infection). From the 25th day onwards developing embryos could be seen in the lungworms situated in the bronchi and by the 30th day embryonated lungworm eggs were found in the bronchial exudate and occasionally in the lung parenchyma. The eosinophil reaction although much less severe than before was still apparent in the lungs especially in the perivascular connective tissue and in that of the interlobular septa and subpleural tissue. Round cell infiltration of the alveolar walls was accompanied by varying amounts of alveolar exudate consisting of oedema fluid, alveolar macrophages, eosinophils, lymphocytes, and some polymorphonuclear leucocytes, and free giant-cells. Occasional clusters of multinucleate cells occurred in the alveoli forming small giant-cell granulomas. In some areas, especially at the periphery of the lung, septal cells lining the alveoli appeared to form a squamous or cuboidal epithelialising layer.

Vesicular emphysema accompanied by round cell infiltration (Fig. 8), lymphoid hyperplasia, and smooth muscle hypertrophy all became more pronounced as the patent phase of the infection progressed, while in addition at about 35 days after infection mucoid metaplasia of the bronchial epithelium commenced. It appeared first as an increase in the number of goblet cells in the epithelium of the small and medium-sized bronchi, later extending so that nearly all the cells of the bronchi in infested areas became mucus-secreting. Large quantities of mucus were seen in some of the bronchi at this stage as well as lungworm eggs, mononuclear cells, eosinophils, and varying numbers of polymorphonuclear leucocytes. The presence of aspirated lungworm eggs and larvae in the lung parenchyma produced reactive changes (Fig. 9) in which the predominant feature was the presence of giant-cells, that could frequently be seen engaged in the active phagocytosis of the parasites. Occasional eosinophil granulomas were present in the lungs at about the 30th day but these were more numerous after 40 days.

(d) *Late Patent Stage* (60 days after infection and over). In the later stages of the disease lymphoid hyperplasia, smooth muscle hypertrophy, and mucoid metaplasia of the bronchial epithelium together with chronic vesicular emphysema, chronic bronchitis, and persisting cellular infiltration became more pronounced. Occasional infiltrates of eosinophil leucocytes remained especially in the alveolar walls, interlobular septa, and in the subpleural tissue. Small granulomas with central foci of amorphous cellular

debris, polymorphonuclear leucocytes, or eosinophil leucocytes were most numerous at 60 days after infection. They were frequently situated close to the pleural surface, and occasionally coalesced to form areas of consolidation (Fig. 10). At 80 days the most pronounced of the chronic lung changes were emphysema and lymphoid hyperplasia. The latter occurred in the bronchial submucosa as well as in the peribronchial tissue causing disruption of the components of the bronchial wall (Fig. 11). Infiltration and desquamation of the epithelium were seen in places and occasional bronchial ingrowths were produced. Stenosis and partial occlusion of the bronchial lumina were also common. The activity of the developing lymphoid follicles in these sites at this stage was reflected in the numerous mitotic figures that were observed in the cell nuclei. Lymphoid follicles coalescing in groups formed early pulmonary lymphoid nodules of the type seen in long-standing natural infections.

Discussion

The importance of correlating the various developmental stages of lungworm infection with the symptoms and morbid lesions produced has been shown by Jarrett, McIntyre, and Urquhart (1957) in studies on experimental bovine parasitic bronchitis. Their studies elucidated the variety of clinical signs that occurred at different stages of the infection in relation to the presence of lungworms or developing larvae as well as to the further effects of infestation such as interstitial emphysema of the lung or pulmonary oedema and dyspnoea syndromes. It was also demonstrated that pathological changes, such as alveolar epithelialisation, pulmonary oedema, hyaline membrane formation, and giant-cell reactions, similar to those occurring in other diseases, were features of Dictyocaulus infection at various stages.

Metastrongyle infection of pigs as an uncomplicated disease appeared in the present studies to be less harmful to the host than the large lungworm infections of other species at comparable levels of infestation. The situation of the parasite in the smaller bronchi and its tendency to remain confined to the margins of lobes together with its predilection for the upper posterior parts of the lungs limited its effect on lung function as a whole. Nevertheless a variety of histological appearances was seen in relation to the developing and mature parasites and as well as pulmonary emphysema caused by bronchial obstruction with subsequent structural changes in the bronchial wall, several types of pulmonary consolidation were observed. These were usually indistinguishable with the naked eye from those seen in virus pneumonia although compared with the latter they were more limited in extent. The earliest consolidation was associated with the dense eosinophil leucocyte reaction that occurred during the immature lungworm phase, and its onset apparently coincided with the commencement of feeding, and excretion of waste products, by the parasites. The intensity of the eosinophil infiltration in the lungs appeared to coincide with the rise in the number of circulating blood eosinophils. The earliest coughing noted was during this stage.

Pneumonia in the patent stage of the disease was often caused by the aspiration of lungworm eggs into the alveoli and was usually of the giant-cell reactive type accompanied by hydrostatic effects in the dependent parts of the lung where it most frequently occurred. The appearance of early lymphoid hyperplasia at this stage and its persistence into the chronic phase should be noted in respect of differential diagnosis from the lymphoid changes in virus pneumonia. The small eosinophil nodules that appeared after 30 days and were most numerous at 40 to 60 days were apparently formed around degenerating lungworm eggs or larvae although the parasites could only be occasionally seen in the sections. The major part of some areas of consolidation was occasionally formed by coalescing nodules of this type.

In the chronic phase of the disease the development of the benign lymphoid nodules characteristic of long-standing cases could be observed. The occurrence of lymphoid tissue in the submucosal and adventitial connective tissue of the small bronchi together with round cell infiltration of the alveolar walls was the predominant cause of consolidation in some areas. This fact is of some importance in relation to differential diagnosis in suspected virus pneumonia and in cases where "virus" and lungworm infections coexist.

Acknowledgments.—I wish to thank Mr. W. L. Moss, for his valuable co-operation in maintaining the cultures of infected earthworms, and Mr. F. H. Summerfield, A.R.P.S., for kindly preparing the photographs.

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UNINSPECTED MEAT

In reply to questions in Parliament on March 9th, Mr. Godber, Joint Parliamentary Secretary to the Ministry of Agriculture, said:—

"I am not satisfied that it is essential to ban Sunday slaughtering yet. That is one of the points we are looking into. I hope that with a certain measure of co-operation between all concerned we shall be able to clear these points up. There is no justification for doing this unless we are satisfied that we cannot get 100 per cent. meat inspection without it."

Sir F. Medlicott: "Is my hon. Friend aware that a very high proportion of the unsatisfactory meat does get through on Sundays when the inspection is less effective?"

Mr. Godber: "That is exactly the sort of thing about which we have been having consultations. I can assure my hon. Friend that I am as anxious as he is to get complete meat inspection."

Current Literature

ABSTRACTS

Observations on Experimental Parasitic Bronchitis in Calves and the Response to Diethylcarbamazine. PARKER, W. H., & ROBERTS, H. E. (1958). *J. comp. Path.* **68.** 402-10.

In an interesting paper which veterinarians in cattle practice might profitably study for themselves the authors report further results of trials with diethylcarbamazine against artificially induced lungworm infestation in 4-month-old calves. Utilising 4 animals in each treated group and 5 control calves it was clearly shown that treatment with 10 mg. per lb. of diethylcarbamazine by the oral or intramuscular route on each of the 14th, 15th, 16th, 17th and 18th days after infection produced an excellent clinical response in a moderately heavy attack of parasitic bronchitis. In the treated animals respiratory rates fell rapidly to normal and appetite and weight gains improved at once whereas the control animals took several weeks to throw off the infestation and return to health and one of them died. It appears that treatment removes the immature worms present in the bronchial tree since very few larvae were passed subsequently in the faeces of the dosed animals.

Some of the calves were given a challenge dose of lungworm larvae 44 days after the initial infection and it was observed that the immune response appeared to be of a lower order in those which had been treated indicating that adult worms may play some part in production of immunity. Lesions in the lungs of animals killed 82 days after the initial infection appeared to be much the same in both treated and control groups. P. A. K.

Hormones in Livestock Production. RANKIN, A. D. (1958). *Vet. Med.* **53.** 643.

Growth stimulation by the addition of diethylstilboestrol to the ration has become widespread, but there is a growing body of evidence that the beneficial effects are not as long lasting as first reports indicated. It would now appear that after 60 days of feeding it might as well be withdrawn from the ration.

The implantation of long lasting pellets of natural hormones or diethylstilboestrol is increasing in popularity. Objections which have been cited are an adverse effect on carcase quality, undue restlessness, changes in conformation such as raised tail heads, patchiness of fat, and udder development. Methods of reducing these side effects have been studied and it was discovered that in steers and in lambs a combination of oestrogen and progesterone in implant form resulted in a modulation of the oestrogenic activity so that the desirable stimulation of weight increase was secured while the side effects were suppressed. These formulations are now produced commercially as a 20 mg. oestradiol benzoate—200 mg. progesterone pellet for steers and a 2·5 mg. oestradiol benzoate—25 mg. progesterone pellet for lambs. In a controlled test at a commercial feed lot the average daily live-weight gain was 2.32 lb. for the untreated controls, 2.85 lb. for the oestradiol–progesterone treated group and 2·53 lb. for steers which received an implant of 24 mg. of diethylstilboestrol. In an experiment with lambs the average daily live-weight gain of the controls was 0·47 lb. and the oestradiol–progesterone treated group was 0·62 lb.

The use of progesterone–oestradiol in heifers was unsuccessful since the combination resulted in an increase in udder and teat development so that a virgin heifer was sometimes judged to be in calf. Testosterone in combination with oestradiol has been used to regulate the side effects, and the formulation which has developed is 20 mg. oestradiol benzoate—200 mg. testosterone propionate. In an experiment with this preparation the average daily live-weight gain of the untreated controls was 2·34 lb. and of the treated heifers 2·64 lb.

A preparation consisting of oestradiol valerate 24 mg., testosterone enanthate 60 mg. and progesterone caproate 60 mg. in the form of an injectable semi-solid paste has been found to be effective in both steers and heifers, and should appear on the market soon. J. O. L. K.

A Comparative Study of the Incidence of Vacuolated Neurones in the Medulla from Apparently Healthy Sheep of Various Breeds. ZLOTNIK, I., & RENNIE, J. C. (1958). *J. Comp. Path.* **68.** 411–15.

Previous work had shown vacuolation of the medulla in apparently normal Cheviot sheep. Since this breed is known to be susceptible to scrapie, brains were examined from apparently healthy Blackface, Welsh Mountain, Down crosses, Columbia, Rambonillet and Hampshire sheep. They came from flocks which were believed never to have been affected with scrapie.

In every breed, vacuolated neurones were found in the medulla, but rarely was the number greater than one per section. G. B. S. H.

An Ultra Short Acting Anaesthetic. LIEBERMAN, LEO L. (1958). *Vet. Med.* **53.** 11. 600–3.

Small-animal practitioners have frequently felt the need for a very short-acting anaesthetic of very low toxicity for such procedures as teeth scaling, dressing of painful wounds, and X-ray work. The author of this paper describes such an anaesthetic.

The action of methitural sodium, given intravenously, is characterised by an extremely rapid removal from the blood stream—50 per cent. having disappeared 20 minutes after an intravenous injection. Only 30 per cent. can be found in the entire carcase 24 hours after injection compared with 90 per cent. thiopental sodium.

Methitural sodium is used for dogs as a 5 per cent. solution with a dosage of 1 ml. per 4 lb. bodyweight. Owing to the rapid elimination from the body it is essential that the intravenous injection be given rapidly. If preanaesthetic sedation is given with such drugs as morphine/atropine, it is found that an anaesthetic dose of 1 ml. per 5 lb. bodyweight will

produce deep anaesthesia and muscular relaxation for 15 to 20 minutes with complete recovery in 1 to 2 hours. The addition of 25 to 30 per cent. pentobarbital sodium will prolong the anaesthetic effect to 30 to 35 minutes.

For cats the solution is diluted to 2½ per cent. and for kittens to 1¼ per cent. German veterinarians have reported the routine use of methitural sodium intraperitoneally for spaying and castration of cats, but in the author's hands this route has produced an irregular response.

Seven individual cases are reported in dogs and cats indicating the uses of the anaesthetic for such conditions as spaying both in dogs and cats, abscess of the anal gland, teeth extraction and the treatment of painful otitis. J. S. J. L.

The Effects of the Continuous Administration of Diets Containing Tetracyclines and Penicillin on the Number of Drug-resistant and Drug-sensitive *Clostridium welchii* in the Faeces of Pigs and Chickens. SMITH, H. WILLIAMS. (1959). *J. Path. Bact.* **77.** 79.

In a series of experiments with pigs and chickens, designed to determine the effects of diets containing either tetracyclines or penicillin under ordinary commercial conditions, the author found that lower numbers of lecithinase-producing *Clostridium welchii* were found in the faeces of antibiotic-fed animals than in those fed on antibiotic-free diets.

In piglets early weaned on to tetracycline diets, the total *Cl. welchii* content in 58·4 per cent. animals was tetracycline resistant. The corresponding figure for older pigs was 17·5 per cent.

In the case of animals on an antibiotic-free diet, there was found to be considerable variation from farm to farm in the numbers of *Cl. welchii* in the faeces. In addition, small numbers of tetracycline-resistant *Cl. welchii* were found in pigs and piglets on these farms. These factors no doubt account for the lack of response to tetracycline feeding on some farms.

Only 5 per cent. of tetracycline-fed chickens had a *Cl. welchii* population predominantly tetracycline-resistant, but it was found that higher dietary levels of tetracyclines gave more effective supression of *Cl. welchii* than lower levels.

A high proportion of tetracycline-resistant *Cl. welchii* was found in the faeces of piglets whose mothers were fed on diets containing tetracyclines.

It was obvious that tetracycline feeding was more effective in producing an *E. coli* faecal flora mainly tetracycline-resistant, than in producing a similar type of *Cl. welchii* faecal flora ; possibly because *E. coli*, being better adapted to colonisation in the intestinal tract, proliferates more freely, in its resistant form, after the suppression of the great mass of intestinal flora by tetracycline feeding.

Mouse infection experiments showed that the tetracycline-resistant *Cl. welchii* as a group were neither more nor less virulent than tetracycline-sensitive ones. Infections by many of them were not amenable to tetracycline chemotherapy, but they remained amenable to penicillin therapy. I. W. J.

The Histopathology of the Brain Stem of Sheep Affected with Experimental Scrapie. ZLOTNIK, I. (1958). *J. Comp. Path.* **68.** (*page to come*).

Vacuolation and degeneration of neurones precedes the clinical disease and is a constant feature of experimental scrapie. G. B. S. H.

Further Studies on the Relationship Between Particle Size and Anthelmintic Efficiency of Phenothiazine. DOUGLAS, J. R., BAKER, N. F., & LONGHURST, W. M. (1959). *Amer. J. Vet. Res.* **20.** 201–5.

Lambs were dosed with 25 g. quantities of N.F. phenothiazine preparations of varying particle sizes. Against the common *Ostertagia*, *Trichostrongylus* and *Nematodirus* species the anthelmintic efficiency increased with decreasing particle size over the range of 16·7–1·9 microns mean particle diameter. The finest material gave an efficiency of over 90 per cent. against the *Ostertagia* and *Trichostrongylus* genera. This result is probably attributable to the enormous surface area of the particles in such a preparation—approximately 25,000 sq. cm. per g. The experimental series as a whole demonstrated a linear relationship between surface area and efficiency.

The authors suggest that a 2 micron preparation of phenothiazine should be aimed at for control of *Ostertagia*, *Trichostrongylus* and *Nematodirus*. They appreciate the technical difficulties involved in producing such material and have made a preliminary investigation of the possibility that purer preparations of phenothiazine might be more active. Their first results suggest that a pure phenothiazine of 4·8 microns mean diameter is as effective as an N.F. grade of 1·9 microns mean diameter. (Particle sizes estimated by a Fisher-Subsieve Sizer). P. A. K.

Promazine—Its Pharmacological and Clinical Effects in Horses—RAKER, C. W., & ENGLISH, B. (1959). *J.A.V.M.A.* **134.** 19.

Following reports of toxicity in both human and veterinary cases treated with the drugs hitherto employed as " tranquillisers," an attempt has been made by the authors to find a drug which will have an equally successful depressant action on the lower centres of the brain, but which will not produce the undesirable changes in the blood which were caused by these earlier drugs.

Promazine hydrochloride (sparine) was administered to horses in doses of 500 mg. intravenously and intramuscularly, repeatedly over a period of two weeks, and no significant changes were produced in the blood picture, apart from a very slight decrease in neutrophils and leucocytes with a relative increase in lymphocytes. The drug caused relaxation in the horses, with decreased response to external stimuli and suppression of fear and aggressiveness, but a full awareness of the environment was retained. When used as a premedicant for anaesthesia the effective dose of anaesthetic agent was markely reduced and recovery from anaesthesia was smooth. U. L.

Study Period at the Civil Defence College, Sunningdale

We are indebted to Major J. H. Wilkins, Chairman of the B.V.A. Atomic Energy Sub-committee, for the following account of a Course which was arranged by the authorities as the result of an approach to the Home Office by the Association. The purpose of this approach was to discuss the specialised services which the profession could offer to Civil Defence.

At the conclusion of the study period, on February 25th, there was a general feeling of optimism and achievement amongst the 78 delegates who attended. The assurance from the senior representatives of the Ministries concerned that, after the facts from the study had been collected, a finalising meeting with the B.V.A. Sub-committee would be held, gave much satisfaction. The continuing object of this meeting would be to promulgate the rôle of the veterinary profession in case of a nuclear disaster.

There is an important niche in Civil Defence which the profession will be required to fill. Two alternative rôles were envisaged at the Course: these were to help the doctors directly to save life or to help ensure food production and thus make a vital contribution to human survival. The consensus of opinion of delegates was heavily in favour of the veterinary profession being placed in an advisory, supervisory, and (in certain specialised aspects) executive positions directly concerned with food salvage and production. The problem of pet animals, it was generally agreed, needed much more study, and the Home Office delegate promised to consult the B.V.A. more closely in future.

The Course itself consisted of up-to-date papers on various aspects of Civil Defence, interspersed with film and discussions on specific questions. Spokesmen were asked to give "potted" conclusive answers to questions and these answers are to be forwarded to the B.V.A. for further study.

Brief details of the Course were as follows. On the first full day, February 23rd, these papers were read:—

Nuclear Weapons and their Effects, by G. Wortley; a concise review of the whole subject.

Effects of Fall-out on Livestock, by J. A. J. Venn; an exposition based mainly on American sources.

The Civil Defence Plan, by S. J. Gray, of the Home Office. This was one of the most important papers in the Course. The Civil Defence Plan, as described, seemed to provide for suitable specialised duties, advisory, supervisory, and executive, which would be undertaken by veterinary officers.

The Agricultural Plan, by Lt.-Col. G. K. Hamilton. It was felt that only a rather vague plan emerged from this well-phrased talk, though clearly many matters had been considered in meticulous detail.

The Veterinary Problem was described by B. A. Claxton, and was, perhaps, rather one-sided, concentrating as it did only on the agricultural side of the problem. It was, however, a lucid presentation of the immensely important work which would fall to the lot of the veterinary surgeon in safeguarding the nation's food supply.

The first day came to a close by the Course being divided into "syndicates" of 8 or 9 members to discuss questions connected with livestock, slaughter programme, and future breeding policy. These discussions continued in the comfortable (and cheap) bar until the small hours of the morning.

The following day commenced with a central discussion conducted by Mr. J. G. Carnochan, Assistant Secretary, Ministry of Agriculture. Each syndicate was asked in turn to give considered answers to the questions set the previous evening. It quickly became evident how profoundly the perspective of members had been re-orientated since their arrival. They had changed from a pessimistic attitude to one of reserved optimism, clearly as the result of learning that they were to be needed as key personnel.

The paper which followed the discussion was given by Dr. L. J. Middleton of the Agricultural Research Council. It was gratifying to hear that the investigations being carried out in this country on the radiation effects on plants, soil, and animals were progressing so successfully. These feelings dissolved when Mr. Wortley followed with some most erudite statistical material, which pleased the more mathematically minded delegates, but left the others a trifle dazed.

There then followed one of the best papers of the Course, by Dr. L. H. Murray of the Ministry of Health on the casualty services. There was a general feeling that this talk should have been given at the beginning instead of at the end of the Course. The speaker dealt with radiation effects and explained very clearly the whole of the hospital and casualty services. In his summing up he emphasised the essential rôle of the veterinary profession either in helping the medical profession directly, or by helping to ensure the continuance of the nation's food supply.

The last morning was devoted to a central discussion meeting, when it was made very clear that the general opinion, in the light of the Course, was that the veterinary profession, whether employed by the State or in private practice, should have as their immediate task the saving of human life in the event of nuclear attack, and that thereafter they should be used to perform strictly veterinary duties including the protection of food animals and other aspects of food conservancy.

Chairmen and spokesmen of syndicates are requested to forward their syndicate replies to Major J. H. Wilkins, R.A.V.C. School, Aldershot, *as soon as possible.*

The Victoria Veterinary Benevolent Fund

A meeting of the council of the Victoria Veterinary Benevolent Fund was held at 10, Red Lion Square, London, W.C.1, on January 30th, when the following members were present:—

Mr. H. W. Dawes (President) in the chair, Mr. H. E. Bywater, Professors R. Lovell, and J. McCunn, Mrs. E. I. Thomson, and Captain W. Watt. Mr. R. V. Thatcher, solicitor, and Mr. C. W. Francis, secretary, were in attendance.

Minutes. The Minutes of the previous meeting, held on November 13th, 1958, having been published in THE VETERINARY RECORD, were taken as read and signed as correct.

Apologies for absence. Letters of apology for absence were received from Messrs. G. Atkinson, E. Clark, Major J. J. Dunlop, Messrs. R. C. U. Fisher, J. A. Flynn, Mrs. D. I. Glover, Messrs. G. N. Gould, L. E. Hughes, J. M. Ingram, D. H. L. Madden, Captain T. M. Mitchell, Mr. G. M. G. Oliver, Professor L. P. Pugh, Messrs. J. N. Ritchie, W. J. B. Robson, Miss V. Tillemont-Thomason, Major C. W. Townsend, Professor W. L. Weipers, Captain A. Whicher, Dr. W. R. Wooldridge, and Major W. H. Wortley.

Correspondence. A letter dated January 12th, 1959, from Messrs. Tomkins & Bowes, solicitors, Bexhill-on-Sea, in connexion with the will of the late Major James Harrison, was considered, and the secretary was instructed as to the reply.

Investments. The treasurer reported that he had arranged for the balance standing in the Donations Account at the end of December, 1958, amounting to £695 19s. 8d., to be invested in the purchase of £793 9s. 8d. British Electricity 4¼ per cent. Stock, 1974/79.

It was resolved that the action taken by the treasurer be approved.

Accountant's report. The following report was submitted and approved, a vote of thanks being accorded to the respective donors:—

	£ s. d.	£ s. d.
Legacy		
From the estate of the late Mr. A. S. Brooksbanks		250 0 0
Donations		
Adams, H. W. J. (in memory of Professor Scorgie)	2 2 0	
British Veterinary Association (share of profits on insurance scheme)	92 5 10	
East Midlands Division (raffle) ...	17 1 0	
Hans, A. J.	10 0 0	
Ladies Kennel Association (per Miss M. Murray)	10 10 0	
Lakeland Veterinary Association ...	10 0 0	
May, Jeremy	1 0 0	
Mid-West Veterinary Association Dinner Dance	52 11 0	
Nelson, E. P.	10 0	
Oliver, D. F.	1 1 0	
Richmond Dog Show (per Mr. S. F. J. Hodgman)	7 7 0	
Society of Women Veterinary Surgeons	4 0 0	
Thompson, E. (per Mr. J. McIndoe)	10 0 0	
Warwickshire Veterinary Club ...	5 0 0	
Wellingborough and District Canine Society (per Dunlop and Edwards)	2 2 0	
Whicher, A.	10 6	
		226 0 4
Collecting Boxes		
Anon.	6 19 9	
Baxter and Forsyth	5 0 0	
Brancker, Miss W. M.	1 11 11	
Bristol University (Professor Ottaway)	1 10 0	
Bruford, J. W.	1 16 0	
Bushman, G. N.	5 0 0	
Central Veterinary Society (2) ...	6 16 2	
Chambers, Franklin, and Chambers	3 3 6	
East Midlands Division	15 7 5	
Eastern Counties Veterinary Society	10 0 0	
Edwards, J. B.	15 6	
Essex Veterinary Society	3 6 0	
Hewer, Spriggs, and Wilson ...	4 10 0	
Hopson, C. G.	3 3 0	
Irwin, T. H. R.	17 6	
Lincs. and District Division ...	9 12 0	
Marshall, W. S.	1 0 0	
Midland Counties Veterinary Association	18 13 2	
Morton, J. T.	2 12 6	
North-Eastern Veterinary Medical Association	5 13 3	
North Wales Division	6 2 2	
Pasfield, J.	1 1 0	
Royal Counties Veterinary Association	10 15 8	
Russell, Miss E. E. B.	2 9 6	
Scottish Branch	2 11 1	
Scottish Regional Group, A.V.T. & R.W.	2 5 0	
Shipley & Son	1 12 0	
South-Eastern Veterinary Association	3 10 0	
South-Eastern Counties Veterinary Society	8 0 0	
South-East Midlands Veterinary Medical Association	6 6 0	
Sussex Veterinary Society	3 0 0	
Walsby and Brown	2 17 8	
West of Scotland Division	2 5 6	
White, J. B.	2 13 9	
Wilkinson, E.	4 3 6	
Wortley, W. H.	14 6	
Veterinary Investigation Officers	7 3 10	
		174 18 10
		£650 19 2

Christmas gifts. The secretary reported that Christmas gifts amounting to £334 were sent out to 42 beneficiaries on December 15th. They were made up as follows:—

13 @ £10	130 0 0	
16 @ £8	128 0 0	
5 @ £7	35 0 0	
1 @ £6	6 0 0	
7 @ £5	35 0 0	
42	£334 0 0	

It was resolved (a) That the action of the executive committee in sending out special gifts in December

to 42 recipients at a total cost of £334, as detailed in the list submitted to the meeting, be, and the same is hereby, approved.

(b) That the letters of thanks received from the recipients be sent to the treasurer of the Ladies' Guild in order that the members of the Guild may know how much their good work is appreciated.

Wortley Axe Bequest. The following report of the meeting of the Wortley Axe sub-committee held earlier that day was received and adopted:—

(1) *Counsel's Fees.* Your committee recommend that the account submitted by Messrs. Geo. Thatcher & Son of £16 12s. 6d. for Counsel's opinions in respect of the Wortley Axe Trust be approved, and that authority be given for its payment out of the Wortley Axe fund a/c.

(2) *Charity Commissioners*

On December 9th, 1958, the President, secretary, and solicitor of the Fund had an interview with Mr. Paluck, representative of the Charity Commissioners, when the views expressed by Council were made known to him. After discussion, Mr. Paluck agreed to put forward the following proposals to the Commissioners for their consideration in preparing a draft scheme:—

(i) That the Council be at liberty to expend £5,000 out of the investments standing to the credit of the Trust in the purchase of land and the erection of two or three homes.

The remainder of the Fund to remain invested and the income therefrom applied for the maintenance and upkeep of the premises.

(ii) That the limit of 30 miles referred to in the bequest in the will should be disregarded.

(iii) That the class of applicants to benefit under the bequest should be enlarged to include the daughters of the deceased members of the profession, and such other dependents as the Council might deem fit, with the consent of the Commissioners.

Among the several matters referred to in the Commissioners' reply of January 1st, 1959, the following observations were made on the Council's proposals:—

(i) The Commissioners regard the sum of £4,500 as the limit for land, and the building of dwellings.

(ii) Agreeable to the removal, if that be suitable, of the requirement of building not less than 30 miles from London.

(iii) The Commissioners do not at present favour the extension of the class of person to be accommodated in the "Homes" to be erected.

Cases

No. 294, daughter of late member. Receiving grant of £2 per week. Case submitted for review. Secretary reported that he had ascertained that this recipient will definitely be eligible for the national insurance pension as from July 16th next, when she reaches her 60th birthday.

It was resolved that the grant be continued until the June meeting when further consideration be given to this case.

No. 311, daughter of late member, aged 61. Income £2 10s. per week national insurance pension, and 33s. per week from the National Assistance Board. Case reviewed. It was agreed that the present grant of 10s. 6d. per week be continued for a further 12 months when the case be further considered.

No. 320, widow, had accident last July when she fractured her thigh. Receiving £2 per week. In view of the recent correspondence received from this lady and a report from a member of the profession, it was decided that the grant be continued until the next meeting when it be reconsidered.

No 322, M.R.C.V.S., aged 69. Cataract developing in both eyes. The secretary reported that, as the V.M.A. of Ireland Advisory Committee had now expressed its warm approval of the proposal made by the Council at its last meeting that the grant in this case be increased to £2 10s. per week as from January 1st, 1959, he had instructed the bank accordingly.

Date of next meeting. It was agreed that the date of the next meeting of Council be left in the hands of the executive committee.

IMPORT OF CHAROLLAIS BULLS

As our readers will know, it was mentioned in Parliament a short time ago that consideration was being given to the importation of a limited number of Charollais bull calves for breeding experiments under the aegis of the Ministry of Agriculture. Despite the promise that the strictest precautions would be taken to see that disease was not imported in this way, certain agricultural interests have protested very strongly against the importation of this breed from France. At the beginning of this week the National Cattle Breeders' Association at a meeting in London decided unanimously to record their strong objection to the proposed imports. A statement issued after the meeting read:—

"This association, representing all the pedigree cattle breeders' associations, has considered a request from the Minister of Agriculture for an expression of its opinion on the proposed experimental importation of bull calves of the Charollais breed.

"It is the unanimous view of the Council that the proposed importation, which has much wider implications than the single introduction of a few animals for experimental purposes, is strongly objected to.

"The Council is informing the Minister that it would be glad to attend a meeting of all interested bodies convened by him, and including representatives of the alleged substantial body of opinion said to be in favour of the importation."

SIR CLEVELAND FYFE

We record with regret the death of Sir Cleveland Fyfe at the age of 71. He was a good friend of the profession and will, of course, be remembered as general secretary of the National Farmers' Union from 1923 to 1944. In 1947 he was appointed organising secretary of the Animal Health Trust and assisted the Trust until 1951. He was a founder-member and past-president of the Worshipful Company of Farmers.

News and Comment

A "BREAK-THROUGH" IN THE ANTIBIOTIC FRONT

We are indebted to Dr. H. Williams Smith for the following note.

Under this heading *The Times* (March 6th, 1959) describes the isolation of pure 6-amino-penicillanic acid from penicillin fermentation products by a team of workers in the Beecham Research Laboratories (*Nature*, January 2nd, and *Lancet*, March 6th, 1959) and hails it as a British discovery of considerable magnitude.

The generally-held view is that the naturally occurring forms of penicillin that have already been discovered, *e.g.* penicillin G and V, are acyl derivatives of 6-amino-penicillanic acid and that the last stage of penicillin biosynthesis is the introduction of acyl side-chains into the basic 6-amino-penicillanic acid molecule. The discovery of these naturally occurring forms has been an extremely laborious trial-and-error business, achieved by altering the conditions in the fermentation brew in the hope that the penicillin mould would then produce a new form of penicillin.

With the isolation of 6-amino-penicillanic acid in pure form it will now be possible to introduce many different chemical groups into its molecule in the chemical laboratory, thereby synthesising many different forms of penicillin which it is hoped will have widely differing therapeutic properties.

The immediate hope is that the new forms synthesised will have wider or different antibiotic spectra than the naturally-occurring forms already available, that they will be the answer to the serious pencillin-resistant staphylococcal problem which confronts our hospitals, that they may be used with safety in people who are now hyper-sensitive to penicillin, and that they will possess other desirable pharmacological properties not possessed by the forms now available. The possibilities from the veterinary point of view are obvious to all veterinary surgeons.

Whether these aspirations will be realised is a matter which time alone will judge. For the moment this new discovery must be regarded as a significant advance on the antibiotic front.

DOGS EXPORTED TO THE ARGENTINE

A member of the profession has drawn our attention to the fairly complicated regulations which govern the export of animals to Argentina. As these regulations include the issue of veterinary certificates our readers may like to note the following extracts, which are those affecting the profession:—

Ports of entry. Equines, dogs, cats, and birds may be landed only at Buenos Aires.

Certificates

Horses, asses, and mules must be accompanied by: (i) certificates issued by the Ministry stating that cattle plague does not exist and has not existed in Great Britain during the 10 years preceding shipment, that glanders and farcy does not exist in epizootic form in Great Britain and that no outbreak of glanders or farcy has occurred in the place of origin of the animals, or within a distance of 20 kilometres (12.4 miles) therefrom, during the 6 months immediately preceding shipment; and

(ii) certificates issued by Local Veterinary Inspectors of the Ministry stating that the animals have been examined and found healthy.

Dogs and cats must be accompanied by: (i) certificates issued by the Ministry stating that rabies does not exist in Great Britain; and

(ii) certificates issued by Local Veterinary Inspectors of the Ministry stating that the animals have been examined and found healthy.

Legalisation of certificates. Certificates must be legalised by the Argentine Consul at the port of shipment. In the case of pedigree certificates, a composite certificate covering any number of animals will be accepted and endorsed as a single document.

UNIVERSITY NEWS

Edinburgh

The undermentioned candidates have passed the Final Professional Examination (Part I) in the subject of Veterinary Hygiene for the degree of Bachelor of Veterinary Medicine and Surgery:—

Ker, John; Neill, Robert H.; and Watson, Ewen E. B.

Illinois, U.S.A.

The fourth biennial Symposium on Animal Reproduction will be held on June 18th, 19th, and 20th, at the University of Illinois. The theme of the programme will be "The Effect of Germ Cell Damage on Reproduction." Inquiries regarding detailed programme and reservations should be addressed to Dr. P. J. Dziuk, 111 Animal Genetics, University of Illinois, Urbana, Illinois, U.S.A.

AN INTERESTING PUBLICATION

We have received a copy of the *Glaxo Veterinary Leader*, a journal in which appear contributions by veterinary and other scientists on the company's technical staff. The contents are varied and interesting and the journal is exceedingly well printed and presented. There are a number of coloured illustrations which lend variety to the pages as well as showing certain conditions in colour to help the clinician. Those responsible for the production of this veterinary journal are to be congratulated on producing so attractive a publication.

HELLEBORE IN VETERINARY MEDICINE

We are indebted to the Editor of *The Pharmaceutical Journal* for permission to reproduce the following extract from an article, "Helleborus in Jugoslav Popular Medicine," by associate-Professor J. Tucakov of Belgrade University.

"Hellebore is used both in veterinary and human medicine, although more frequently in the former. The veterinary use of the plant is well known among

peasants south of the Sava and Danube rivers, the dried root of a plant having only a single leaf and no flowers being the most highly prized. The harvesting time is important, for it is widely believed that a root gathered on the morning of May 6th—which is when the peasants celebrate the New Year—is much more active than any other. Hypodermic application is the commonest method of use, the technique being as follows: The animal's skin is raised by pinching it between two fingers and a small double slit is made in the two folds of skin with a lancet. A small piece of the root, about the size of a matchstick, is passed through these two openings and secured by a thread to prevent the animal from removing it by rubbing, and to facilitate its extraction after the requisite period of time. The treatment results in the development of a large local area of inflammation which begins to appear after an hour or so and thereafter steadily increases. Most peasants believe that by provoking a large artificial abscess in this way on the ear, tail, or other part of the animal's body, they can draw out congestion, inflammation, and similar ailments affecting a number of organs, in particular the heart.

"Usually the root is left in the skin for 24 hours, although if the animal is very small or weakened by illness the period is shortened accordingly. Occasionally it so happens that a small piece of the root remains in the skin when the rest is removed, and this can prolong the inflammatory period to two to three weeks. In cases of gastro-intestinal troubles, the root is sometimes inserted in the skin of the tail. Strange to relate, stock which has been so treated always fetches a higher price in the markets, the country people believing that the animals have thereby acquired immunity to many ailments. Indeed, it is the custom among peasants on the outskirts of Kragoujevats to "immunise" young pigs every spring with hellebore.

"Oral administration of hellebore is considered to be particularly dangerous, and, for this reason, is much rarer. Nevertheless, it is still practised in certain backward villages in Eastern Serbia. Cattle are given a piece of root, somewhat smaller than a matchstick, in a mixture of salt and maize flour, together with other plants whose names have some symbolic significance. This usually takes place at sunrise on New Year's Day and is the occasion for a special ceremony in the interests of health, fortune, prosperity, good luck, and fertility. However, the drug is often given during the summer and invariably when there is a local epidemic or when an animal is ill. In such cases the ceremony is dispensed with. Until the discovery of DDT and other synthetic insecticides a decoction of hellebore with or without veratrum was used extensively as a wash for scabious or lousy animals."

HOLIDAY EXCHANGES

France

Girls. Martine Bardonneche, aged 16, of the Hautes-Alpes region in the south-east of France, would like to arrange an exchange holiday in England for 1 month.

Marie-Claude Bru, aged 15, would also like to arrange an exchange holiday. She would like to stay with a family on the south coast, if possible, as she is interested in swimming, tennis, and horse riding. Her home is in Esternay (Marne), and she hopes to come to England for a period of 3 weeks to 1 month.

Mlle. Delton of Sainte-Sévère (Indre), aged 16, would like to exchange with a girl of her own age living in or near London.

Michère Ducom of the Sarthe region in the west of France is also anxious to come to England: she is aged 15, and has no particular preference for any part of the country in which she would like to stay. Mlle. Metayer, aged 15, who lives in a small town in Vendée in the western part of France, also hopes to come to England under the same terms.

Edith and Anne-Marie Mignolet, aged 15 and 16, respectively, hope to arrange a stay of 1 month in England during the summer; they would then return to France with their hosts for an exchange holiday in a village in the Loire-Atlantique region of France.

Boys. Bernard Frey, aged 14, of Reims, would like to come to London for about 1 month during July or August, the details of the exchange to be worked out by the families concerned.

Yves Labruyere, aged 16½, is anxious to contact a boy of his own age with a view to arranging an exchange holiday of 15 days to 3 weeks. He would like to correspond with his colleague as soon as possible, and he lives in the Pas de Calais region of France.

Jacques Marchand, aged 15½, of Rouen, would like to spend 15 days at Easter with an English boy, and entertain his host at his home for 15 days in July, August, or September of this year.

Christian Vives, aged 16½, also wishes to entertain an English boy at his home in the Eure-et-Loir region for as long as possible during the Easter holidays, and visit his friend in England during the summer holidays.

Paying Guest. A French veterinary family would like to arrange for their son, aged 13½, to stay with an English veterinary family as a paying guest during the summer months.

Au Pair. A French veterinary family offers a room to an English girl in Paris in exchange for English lessons. It would be possible for the girl to stay for several weeks or several months, as she wished.

A French girl, aged 19, offers her help as a children's nurse maid in exchange for board and lodgings.

Germany

Dr. Meyer of Westerhausen would like to arrange an exchange visit for his 15-year-old son, the English boy to visit Germany in the summer holidays of this year and his own son to make the return visit in 1960.

Members of the profession who may be interested in contacting some of the families listed above are asked to address their enquiries to the Editorial Department of THE VETERINARY RECORD.

R.C.V.S. OBITUARY

We record with regret the death of the following member of the profession:—

SHEATHER, A. Leslie, D.SC., M.R.C.V.S. Qualified at the Royal Veterinary College, London, 1906. Died February 23rd, 1959.

PERSONAL

Births

CHURCHILL.—On March 9th, 1959, to Audrey, wife of Anthony Edward Churchill, B.VET.MED., M.R.C.V.S., of "Sandringham," Walford Road, Ross-on-Wye, a daughter, Judy Louise.

FORSYTH.—On March 4th, at 58, Leeds Road, Selby, to Rosamund, wife of Douglas W. Forsyth, M.R.C.V.S., a daughter, Susan Rosamund, a sister for Michael and John.

JONES.—On February 17th, 1959, to Jean, wife of W. Ashwynne Jones, M.R.C.V.S., of 4, Collingwood Avenue, Rugby, a daughter, Shân Anne.

RANDLESOME.—On February 11th, 1959, to Menai, wife of A. G. C. Randlesome, B.VET.MED., M.R.C.V.S., at 2, Prospect Villas, Falmouth, Cornwall, a son, Neil Anthony.

WILLIAMSON.—On March 6th, 1959, at the Nightingale Maternity Home, Derby, to Marion, wife of Alan Williamson, B.V.SC., M.R.C.V.S., a son, David Andrew.

COMING EVENTS

March

18th (Wed.). Annual General Meeting of the Scottish Metropolitan Division in the Royal (Dick) School of Veterinary Studies, 2.45 p.m.

Meeting of the Southern Counties Veterinary Society at the Grand Hotel, Bournemouth, 7.30 p.m.

Spring Meeting of the North of Scotland Division in the Northern Hotel, Aberdeen, 2.30 p.m.

19th (Thurs.). General Meeting of the Society of Practising Veterinary Surgeons at the Grand Hotel, Peterborough, at 2.30 p.m.

General Meeting of the Herts. and Beds. Division at the Sun Hotel, Hitchin, 7.30 p.m.

20th, 21st and 22nd (Fri., Sat. and Sun.). Conference of the British Small Animal Veterinary Association in London.

25th (Wed.). Spring Meeting of the Lincolnshire and District Division at Eastgate Court Hotel, Lincoln, at 2.15 p.m.

Ordinary Meeting of the Sussex Veterinary Society at the Old Ship Hotel, Brighton, 2.30 p.m.

General Meeting of the Lancashire Veterinary Association at Alderley Park, Cheshire, 2.30 p.m.

26th (Thurs.). Meeting of the Shropshire Veterinary Club at the Oak Hotel, Shelton, Shrewsbury, 8 p.m.

April

1st (Wed.). Meeting of the R.A.V.C. Division at Glaxo Laboratories Ltd., Greenford, Middlesex, at 11 a.m.

2nd (Thurs.). General Meeting of the Society of Practising Veterinary Surgeons at Langford, Bristol.

2nd and 3rd (Thurs. and Fri.). The 21st Ordinary General Meeting of the A.V.T. and R.W's. will be held at the Gleneagles Hotel, Scotland, at 10 a.m.

4th (Sat.). Symposium of the Scottish Group of the Nutrition Society in Glasgow.

13th Annual Dinner of the B.R.X. Club at the Royal Veterinary College, 6 p.m.

7th (Tues.). Reception and Dance of the Shropshire Veterinary Club at the Lion Hotel, Shrewsbury, 9 p.m.

8th, 9th and 10th (Wed., Thurs., and Fri.). B.V.A. Committee and Council Meetings in Edinburgh.

25th (Sat.). Meeting of the B.S.A.V.A. North West Region at the Stork Hotel, Liverpool.

May

1st (Fri.). Reception and Dance of the Midland Counties Veterinary Association at the Mount Hotel, Tetterhall Wood, Wolverhampton, 9 p.m.

August

30th to 5th September. 77th Annual Congress of the British Veterinary Association in Folkestone. (Official opening Monday, August 31st.)

B.V.A. COMMITTEE AND COUNCIL MEETINGS IN EDINBURGH

Wednesday, April 8th, 1959—at The Royal (Dick) School of Veterinary Studies

10.00 a.m. Farm Livestock Committee.
11.30 a.m. Parliamentary and Public Relations Committee.
2.15 p.m. Small Animals Committee.
5.00 p.m. Finance Sub-committee.

Thursday, April 9th, 1959—at The Royal (Dick) School of Veterinary Studies

10.00 a.m. Home Appointments Committee.
11.30 a.m. Veterinary State Medicine Committee.
2.15 p.m. General Purposes and Finance Committee.

Friday, April 10th, 1959—at The Royal (Dick) School of Veterinary Studies

10.00 a.m. Council Meeting.

ADDRESSES OF DISEASE INFECTED PREMISES

The list given below indicates, first the county in which are situated the premises on which disease has been confirmed, followed by the postal address and date of outbreak.

Anthrax

Ayr. Nether Barr Farm, Barr, Girvan (Mar. 4).
Cambs. Mill Farm, Sawston (Mar. 6).
Cornwall. Boswin Farm, Porkellis, Helston (Mar. 9).

Cumberland. Dryholme, Silloth, Carlisle (Mar. 4).
Kirkcudbright. Netherlaggan Farm, Parton, Castle Douglas (Mar. 9).
Norfolk. Corbetts Lodge Farm, Necton, King's Lynn (Mar. 6).
Suffolk. Searsons Farm, Trimley St. Mary, Ipswich (Mar. 4); Black Barn Farm, Charsfield, Woodbridge (Mar. 9).
Yorks. 21, Leconfield, Beverley (Mar. 4).

Fowl Pest

Cambs. Home View, Little Thetford (Mar. 7); The Elms, Haddenham (Mar. 9).
Herts. Rectory Park, Great Hallingbury, Bishop's Stortford (Mar. 5).
Lincs. Poplars Farm, E. Heckington, Heckington, Boston (Mar. 7).
Norfolk. Hackford Road, Wicklewood, Wymondham (Mar. 6).
Suffolk. Nearby, Hitcham, Ipswich (Mar. 3); 86, Bury Road, Brandon (Mar. 5).
Surrey. 26, Croydon Lane, Banstead (Mar. 6); 7, Beckenshaw Gardens, Woodmansterne, Banstead (Mar. 7).

Swine Fever

Ches. Yew Tree Farm, Bidston, Birkenhead; Bankdale Piggeries, Dibbinsdale Road, Bromborough, Wirral (Mar. 4); 70, Greasby Road, Greasby, Wirral (Mar. 9).
Denbigh. Sycamore Farm, Penycae, Wrexham (Mar. 3).
Derbys. Town Farm, Bretby (Mar. 9).
Devon. Downlands, The Common, Lympstone, Exmouth; Higher Shelves, Ridge Road, Solomons Post, Maidencombe, Torquay (Mar. 3); The Barton, Dunchideock, Exeter (Mar. 4).
Essex. Lawns Farm, Great Leighs, Chelmsford (Mar. 6); Holm Lodge, Chitts Hill, Lexden, Colchester; Marsh Farm, Alresford, Colchester; Lower Farm, Brightlingsea (Mar. 9).
Kent. Evelyn Cottage, Downs Road, Northfleet, Gravesend (Mar. 3); Turn Again Farm, Wilmington, Dartford (Mar. 4).
Lancs. Swainson House Farm, Goosnargh, Preston (Mar. 5); Orchard Farm, Lords Lane, Risley, Warrington (Mar. 6).
Lincs. The Piggery, Anchor Lane, Ingoldmells, Skegness (Mar. 3).
Norfolk. The Hall, Flordon, Norwich (Mar. 3).
Northants. Moulton Park Farm, Moulton (Mar. 9).
Notts. Eel Hole Farm, Watnall (Mar. 9).
Northants. Cockbank, Grassmoor, Whittlesey, Peterborough (Mar. 3).
Somerset. Rose Cottage, Rooksbridge, Axbridge (Mar. 9).
Suffolk. Green Farm, Redlingfield, Eye (Mar. 9).
Warwicks. Radbrook Farm, Preston-on-Stour, Stratford-on-Avon; Home Farm, Sulby, Rugby (Mar. 5).

Letters to the Editor

The views expressed in letters addressed to the Editor represent the personal opinions of the writer only and their publication does not imply endorsement by the B.V.A.

A Case of Acute Septicaemia in the Race-horse

Sir,—It would appear from Mr. T. F. Arnold's letter in THE RECORD of January 3rd that I left out two very important aspects of this case:—

(a) This horse was a very free sweater.
(b) He was in very good condition.

On looking back in my case-book this was the first occasion on which I ever had to treat this horse except having point-fired him for splints. The temperature in Malaya is fairly constant throughout the year at 94° F.; in northern Malaya, from where this case is reported, the hot season is Dec.-Feb. where temperatures may reach 100° F. in the shade. Early morning, however, is the coolest time of the day.

Yours faithfully,
JAMES H. MARSH.

32 Scotland Road,
Penang.
February 23rd, 1959.

Control of Lungworm Disease in Calves

Sir,—During the summer of 1958 observations were made of the effect of regular monthly administration of cyanacethydrazide on the incidence of lungworm disease on infected farms.

Herds were selected which were known to have a past history of parasitic bronchitis and in which deaths from the disease were known to occur. Their geographical distribution was wide—County Mayo, Devon, Buckinghamshire, Leicestershire, Northamptonshire, Cumberland, and Yorkshire.

Twenty-five farms were observed, with a total of 589 calves. Three hundred calves on 8 farms were dosed twice, in August and September; 75 calves on 2 farms were dosed 3 times, in July, August and September on 1 farm, and in May, June and August on the other. The remaining 214 calves on 15 farms were dosed 4 times, from June to September inclusive. One hundred and sixty-five calves on 5 farms were treated by injection and the remainder dosed orally.

In 2 groups only was a minor outbreak of bronchitis noted, and in each of these a few animals had been left untreated as controls. One outbreak responded immediately to cyanacethydrazide and the other was too mild and transient to need treatment.

The remaining groups remained entirely free from the disease.

It is hoped to continue these observations on a wider scale in 1959.

I am indebted to the veterinary surgeons in charge of the farms for their active assistance and co-operation in these observations.

Yours faithfully,
W. T. HARROW.

Veterinary Department,
Imperial Chemical Industries Ltd.,
Fulshaw Hall,
Wilmslow,
Cheshire.
March 6th, 1959.

R.C.V.S. Council Elections

Sir,—May I, through your columns, address those gentlemen who are offering themselves as candidates for the forthcoming R.C.V.S. council elections?

In order to help the voters make their choice, will they be kind enough to indicate their views on the following subjects, also giving their ideas as to

how the problems involved might be solved:—

The importation of foot-and-mouth disease from Argentina.

The lack of a properly organised meat inspection service in the United Kingdom, under direct veterinary control.

The present uncontrolled status of hog cholera in the United Kingdom.

The adequacy of salaries for veterinary surgeons in the public service, both at home and in the colonial territories, including university teachers.

The adequacy of insurance examination fees paid to veterinary surgeons.

Any other subjects of veterinary interest, on which they may hold strong views.

I trust, Sir, that you would publish such observations as may be made.

Yours faithfully,

J. N. SIMPSON-WHITE.

9,629 San Luis Avenue,
South Gate,
California,
U.S.A.

March 1st, 1959.

The Spread of Brucellosis within Herds—the Milk Problem

Sir,—In the brucellosis survey report (Kerr, Pearson & Rankin, 1958), it was stated that there were a number of herds infected with *Brucella abortus* without the farmer being aware of this state of affairs. Further investigations showed a considerable number of infected udders in these vaccinated herds, with few or no abortions. In the course of eradication experiments further herds were discovered showing a similar history featured by blood test positive, milk test positive, and 80 per cent. of milks culturally positive. Owing to the history of adult vaccinations the blood test in these herds was rendered difficult.

The clinical indications and the position of the cows in the byres strongly suggested that infection was passing from udder to udder by the milking process. Cotton (1932) showed that Brucella organisms could penetrate the unbroken skin, and also that when it was shaved and abraded 100 per cent. infection resulted. It was clinically evident in these particular herds that the spread was facilitated, in particular, by the milking machine. The action of the machine may be regarded as having an abrading action on the teat. In addition, Davidson and Slavin (1958) have shown that the cups carry mastitis infection from one cow to another despite dipping between cows.

At this stage it was obviously necessary to confirm that this method of spread could be experimentally produced. This was done by infecting the teats of vaccinated non-infected cows by milking with hands bathed in milk from an infected udder. This was carried out 4 times at three-day intervals. The organism appeared in the milk of the subjected quarter in large numbers, the earliest being two days after the last infected milking, *i.e.* 14 days after the initial exposure. The earliest evidence of the organism in the non-infected quarters was 42 days. The blood titres, 1:5 to begin with, became positive before the organism appeared in the treated quarters, and eventually reached 1:1,280.

The history of one of these vaccinated milk spread herds is given as an example of the difficulties of this problem. This herd has a history of complete vaccination including cow vaccination for some 12 years. At the initial survey of this herd in 1957 6 milk reactors were discovered. This was the first intimation to the farmer that the disease existed in his herd as no recognisable abortions had taken place. The herd was tested a year later and one of the reactors was still found to be present in the herd, regarded as being in isolation, though not strictly in milking isolation. From this stage active steps were taken towards eradication. A further 6 cows were found to be blood and milk positive, 5 culturally positive. The blood test was complicated by the persistence of vaccination titres. On short interval tests of 2 months, 8 further cows were discovered by test. Of these 14 milk-positive cows 11 were cultural positive. The latest tests are negative, and the herd may now be free. In this vaccinated herd of 36 cows, and in the absence of classical Brucella abortions, 20 cows had been removed as udder infected. It was obvious from our experience of this and other herds that it is not sufficient to isolate infected cows at, near, or about the time of calving. Udder-infected cows must be found early and removed for slaughter, otherwise they must be kept in isolation, particularly milk isolation. The spread from udder to udder is insidious and is dangerous in that neither the farmer nor the veterinary surgeon can recognise the infected udder without recourse to milk test and culture. Consideration must also be given to the contamination of food and pasture by infected milk.

The lymph glands, udder, and uterus from field-infected cows in the eradication experiment are subjected to cultural examination. It is significant that 80 per cent. at this stage of the experiment are infected in the udder and its associated lymph glands.

In only 10 per cent. of the cows at *post-mortem* has the organism in addition been cultivated from the uterus and the adiacent iliac glands. The organism has not yet been isolated from the spleen or any other lymph nodes in these chronically infected non-aborting cows. This may be related to the immunity complex of the udder of vaccinated cows (Kerr, Pearson & Rankin, "The Bovine Udder and its Agglutinins," in press).

Yours faithfully,

W. R. KERR,
J. E. F. RANKIN.

Veterinary Research Division,
Stormont,
Belfast.

February 10th, 1959.

References

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DAVIDSON, I., & SLAVIN, G. (1958). *Vet. Rec.* **70.** 44.
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